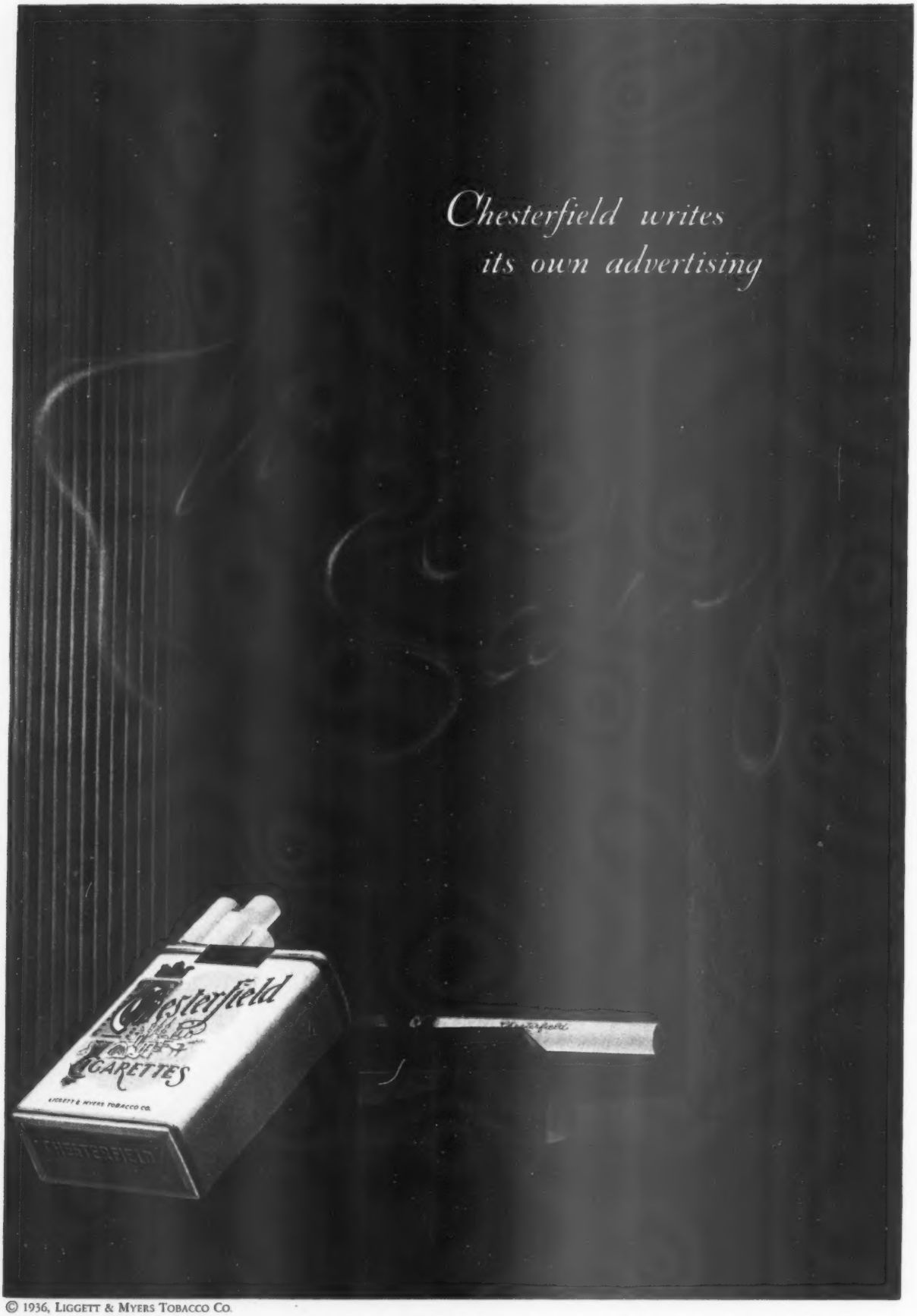
DUPLICATE
N. Y. S. L.

AUGUSTUS WADSWORTH

May 1936

TECHNOLOGY REVIEW

Title Reg. in U. S. Pat. Office



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THE TECHNOLOGY REVIEW, May, 1936. Vol. XXXVIII, No. 8. Published monthly from October to May inclusive and in July at 10 Ferry Street, Concord, N. H. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription $3.50; Canadian and Foreign subscription $4.00. Entered as second-class matter at the Post Office at Concord, N. H., under the Act of March 3, 1879.

THE TABULAR VIEW

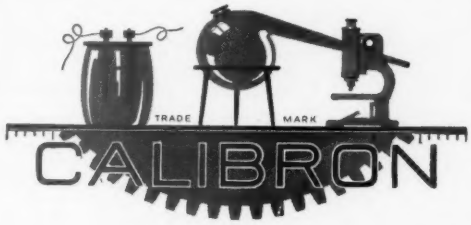
THE author of "Science and the Fine Arts" (page 339), RALPH G. HUDSON, '07, is Professor of Electrical Engineering at the Institute and is in charge of the Course in General Science and General Engineering. He is the author of five books in the technical field and for many years has been chairman of the Committee on Graduation Exercises and Senior Week at Technology. ¶ Professor Hudson, prompted by the conundrums submitted by Review readers and published in the last issue of The Review, has submitted the following problem:

Each dash in the following sentence represents a letter; each group of dashes contains all the letters of the preceding group plus one new letter; the sequence of the letters need not be the same. The problem, of course, is to supply the missing words.

– DO NOT LIKE –– SAID THE MAN WITH THE BLACK ———. THE ———— WE HAVE WITNESSED IS IMPRESSIVE BUT WHEN YOU ————— A MAN YOU ——————— A ——————— POWER OF INVESTIGATION. THERE IS BOUND TO BE A ————————— AGAINST ———————— WHEN THE ———————— OF THIS IS REALIZED. IF THE PRACTICE SHOULD PROVE TO BE AN ———————— OTHER ———————— MIGHT FOLLOW.

SINCE leaving M.I.T. in 1925 MALCOLM G. DAVIS has been engaged in various types of work in the utility industry. Several years of this period were spent in California, first with one of the large electric utility systems and later as a member of the technical staff of the California Railroad Commission. Subsequently he has been engaged in rate work in the East as director of rates for one of the larger utility systems. As a member of the firm, Public Utility Consultants, in Pittsburgh, he has devoted a portion of his time to general consulting work in the field of public utility economics, rates, and sales development. ¶ PHILIP M. MORSE, who reviews Mr. Gray's book in the Trend of Affairs section, is Associate Professor in the Department of Physics at M.I.T. Last month he contributed the article on metallurgy entitled, "Wolf's Clothing," and in the February issue, a paper on the neutron. ¶ Other contributors to the Trend of Affairs section include FREDERICK G. FASSETT, JR., Assistant Professor of English at the Institute, and members of The Review Staff.

AS the fourth member of the Cover Club we present WILLIAM E. DAVIDSON, graduate in civil engineering from Rensselaer in 1934, now working as timekeeper for the American Bridge Company on the San Francisco-Oakland Bay Bridge. The photograph on the cover of this issue was taken from a catwalk looking down through the X bracing of one of the bridge towers. In the water, far below, may be seen the ferries which operate in the Bay. ¶ Several readers have requested reprints of the reading list in the March Review. Unfortunately it was not reprinted, but if there is sufficient interest, future lists will be reprinted.



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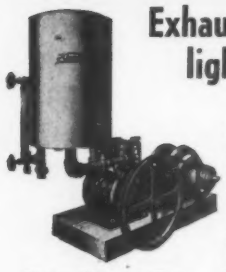

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MAIL RETURNS

Unity

From R. E. DIMOCK, '04:

Recently my wife read in The Review "Soliloquy in a Laboratory," and remarked, "What a fine bit of poetry to be published in a magazine devoted to science." The reply was: "Would you expect The Review to publish anything other than fine material?"

"But," she said, "this is an unusual bit of poetry."

"And," I replied, "The Review is an unusual magazine."

Answered — "I agree it must be so."

For once The Review created harmonious unity.

Sydney, Nova Scotia

Unbelievable Odds

From H. B. RICHMOND, '14:

I assume that the large number of names that have been associated with the development of photographs by telephone, a subject covered admirably in the April issue of The Technology Review, prevented you from making any direct reference to any particular person. I think, however, that somewhere appropriate mention should be made of Austin G. Cooley, '24 (see page five of the March, 1936, issue of *Electronics*).

The reason for mentioning Cooley is that he worked against almost unbelievable odds and did not have placed at his disposal the elaborate facilities of Bell Laboratories. This latest development of low-cost wire transmission by the New York *Times* subsidiary is the work of Cooley.

Cambridge, Mass.

Nature of the Capitalist Crisis

A reader of The Review, inspired by Dr. Dewey's article, "No Economist Can Be Indifferent," in the March issue, writes: "I have been trying for some time to get arguments against [John] Strachey, but have had small success, and am writing in hope that you know of a few good pieces that specifically refute the arguments that he puts forth."

The Review referred this request to B. A. Thresher, Assistant Professor in the Institute's Department of Economics and Social Science, and he writes:

I do not know of any refutation which is directed specifically at Strachey's "The Nature of the Capitalist Crisis." I think, however, that the relevant material might be roughly divided into three parts:

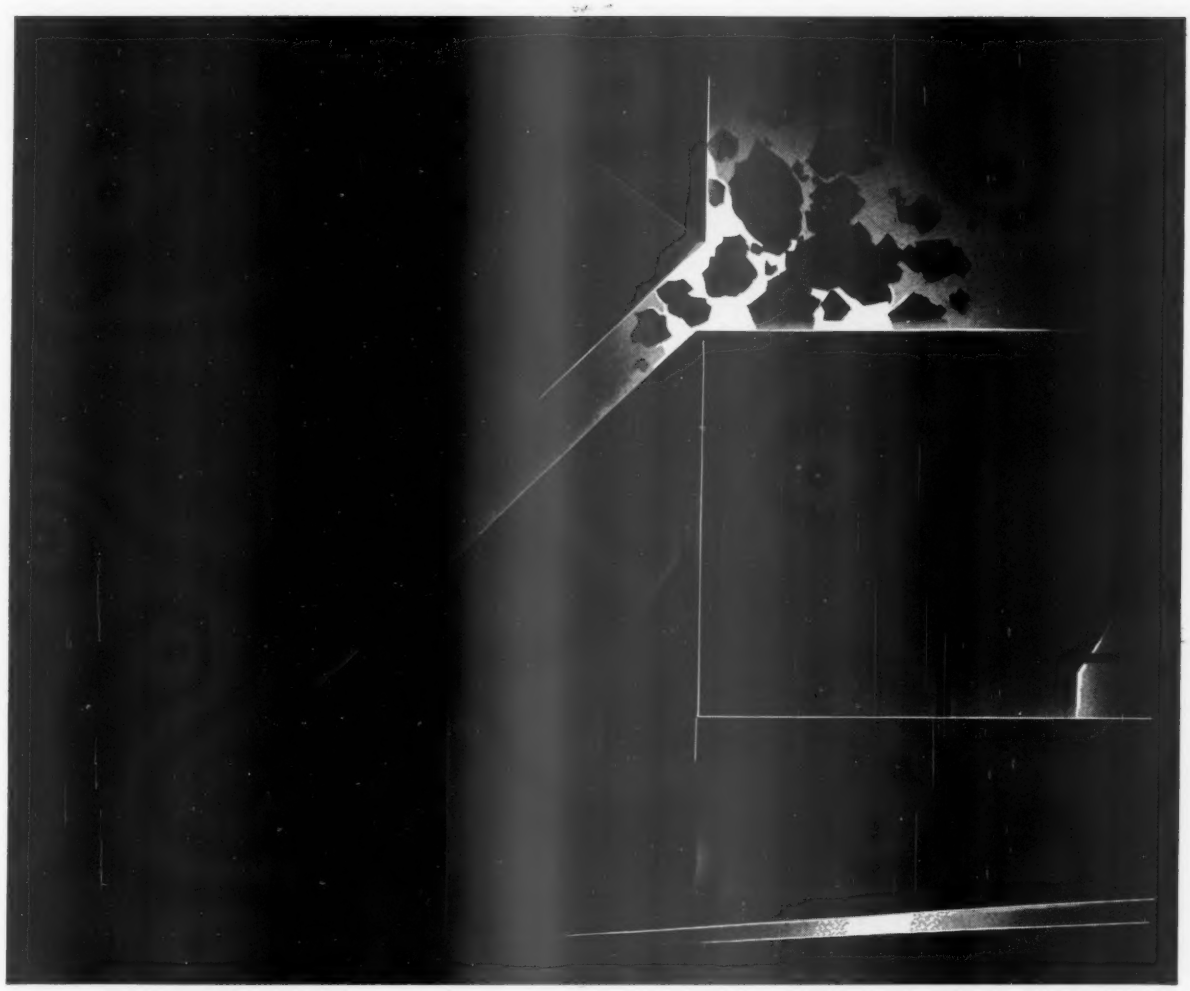
(1) General criticism of the whole Marxian position, for which I think M. M. Bober's "Karl Marx's Interpretation of History" is very useful, as well as Harold J. Laski's book on "Communism."

(2) The Marxian theory of commercial crises, which is Strachey's particular concern. This of course opens up the entire huge area of business cycle theory, to which the best introduction on a scientific plane remains Wesley C. Mitchell's "Business Cycles: The Problem and Its Setting."

(3) The large literature on the feasibility and desirability of economic planning, which of course is implied in any kind of communist program. Here again the range is enormous, but I might mention three books of which I wrote a brief comparative review which appeared in *Mechanical Engineering* for February, 1936. These are Harold Loeb's "The Chart of Plenty"; Barbara Wootton's "Plan, or No Plan"; and Walter Lippmann's "The Method of Freedom." These three books are not all equally valuable, but I selected them for joint review because I think they illustrate very nicely the contrasting points of view from which the subject may be approached.

Miscellaneous

On page 284 of its April issue, The Review published a picture of Technology's champion 1887 tug-of-war team and asked if anyone could identify the stalwarts. Reponses, prompt and in complete agreement, were received from several readers including George C. Wales, '89, the noted artist, and R. G. Luther of the What Cheer Mutual Fire Insurance Company and Hope Mutual Fire Insurance Company.



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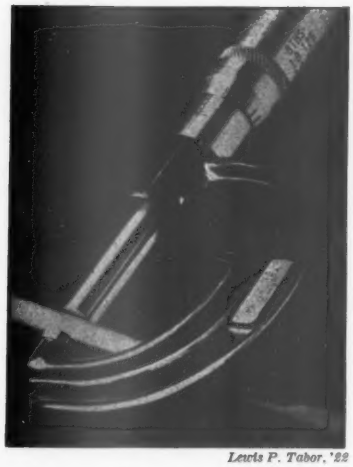

Lewis P. Tabor, '22

THE TECHNOLOGY REVIEW

Title Reg. U. S. Pat. Office

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOL. 38, NO. 8 CONTENTS MAY, 1936

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From a photograph taken from the San Francisco-Oakland Bay Bridge by William E. Davidson

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Harold E. Lobdell

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John J. Rowlands

Business Manager
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John Ely Burchard

PUBLISHED MONTHLY FROM OCTOBER TO MAY INCLUSIVE AND IN JULY ON THE TWENTY-SEVENTH OF THE MONTH PRECEDING THE DATE OF ISSUE AT 50 CENTS A COPY. ANNUAL SUBSCRIPTION $3.50; CANADIAN AND FOREIGN SUBSCRIPTION $4.00. PUBLISHED FOR THE ALUMNI ASSOCIATION OF THE M. I. T. EDWARD L. MORELAND, PRESIDENT; MARSHALL B. DALTON, C. A. SAWYER, JR., VICE-PRESIDENTS; CHARLES E. LOCKE, SECRETARY; J. RHYNE KILLIAN, JR., TREASURER.

PUBLISHED AT THE RUMFORD PRESS, 10 FERRY STREET, CONCORD, N. H. EDITORIAL OFFICE, ROOM 11-203, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE A, MASS. ENTERED AS SECOND-CLASS MAIL MATTER AT THE POST OFFICE AT CONCORD, N. H. COPYRIGHT, 1936, BY THE ALUMNI ASSOCIATION OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY. THREE WEEKS MUST BE ALLOWED TO EFFECT CHANGES OF ADDRESS. BOTH OLD AND NEW ADDRESSES SHOULD BE GIVEN.

Infrared

In the foreground, the Schuylkill River; beyond, Philadelphia's great Art Museum. The eerie quality of the picture is the result of exposing with infrared light which the eye never sees. From a photograph by Lewis P. Tabor, '22

THE
TECHNOLOGY
REVIEW

Vol. 38, No. 8 May, 1936

The Trend of Affairs

Specks of Dust

WHEN a particle of soil from a Kansan wheat field whirls into the air on the wings of a dust storm it joins a motley host of microscopic fragments, a world fellowship of dust that fills the atmosphere and roves with the winds for thousands of miles. Dust specks know no class distinction, for theirs is a community which draws its incalculable multitude from the earth and from interplanetary space in the timeless process of comminution. As civilization advances and the industry of man adds new forms or hastens the natural process of attrition, the world of dust becomes a problem of great scientific concern to which more attention is now being devoted than ever before.

A great deal of the dust of the atmosphere is composed of the earth's soil and vast quantities of particles from the smoke of cities. It is estimated that London alone gives up 7,000,000 tons of smoke a day, thus releasing at least 400 tons of soot particles, a somber legion of fragments that reduces London's share of summer daylight by one sixth. A study by the United States Public Health Service of the effects of smoke in reducing light in New York in January, 1927, showed an average loss of daylight on sunny days of approximately 42% at eight o'clock in the morning. The loss at the same hour in June was approximately 33%, while at noon it was but six per cent. Therefore, smoke abatement, one of the goals of public health engineers for many years, is of paramount importance.

That the number of dust particles in the air varies greatly is indicated by observations at various locations and levels. For example, a cubic foot of air on a New York street has been found to contain 118,000 particles, while at the tenth floor of the Woolworth Building a count of only 72,000 was obtained; at the 58th story the count dropped to 23,000 particles. The inquisitive nose that ventures into an iron grinding room, however, encounters from 14,800,000 to 48,700,000 dust particles per cubic foot. A New York subway platform has given counts ranging from 1,130,000 to 2,320,000 particles, while a cubic foot of business-office air may contain from 128,000 to 172,000 dust motes.

Analysis of a dust cloth in a New England household might at various times of the year show a strange company of tiny particles. It would not be surprising to find a few lonely specks whipped from a Texan garden by a dust storm, smoke particles from a forest fire in northern Canada, volcanic dust from a Pacific island, industrial fragments from factories for miles around, salt particles snatched from the spindrift of the sea by the east wind, and possibly some star dust. There would likely be representatives from the plant and animal kingdom, including scales, seeds, spores, bacteria, plant cells, algæ, rotifers, microscopic fragments of hair, feathers, tissue, and fibers. The mineral world might have as its representatives silica, aluminum silicate, calcium carbonate, calcium phosphate, magnesia, iron oxide, sodium chloride, and many others.

Dust apparently exists at great heights above the earth's surface, for samples of air collected by the Institute's meteorological observation airplane at an altitude of 20,000 feet held many interesting specimens. This study of the distribution of dust and bacteria in the atmosphere is continuing under the direction of Professor Bernard E. Proctor, '23, of the Department of Biology and Public Health. Some investigators believe the air is sterile many miles above the earth.

It must not be concluded that all the inhabitants of the world of dust are malevolent. Some dust is highly desirable, for these infinitesimal particles are the nucleuses upon which water vapor condenses to form rain and

Lewis P. Tabor, '22

Guiding a telescope during the making of a spectrogram on a winter's evening at Gustavus Wynne Cook's Roslyn House Observatory outside Philadelphia

clouds. Through their influence as bearers of raindrops and fog particles, dust specks control humidity and temperature to a remarkable degree. So thank the dust when clouds form and mask the face of the burning sun on an August day.

To the casual observer dust is just dust, but to the scientist there are any number of dust classifications, some of which raise humble specks to positions of great importance. For the sake of simplicity let us consider atmospheric dust as the common variety that mars the polish of the piano. Under ordinary conditions this dust group is simply a household nuisance, perhaps a bit irritating to the nose and eyes, though not particularly dangerous. Add a few particles from the dried sputum of a person suffering from a communicable disease and the potentialities are quite different. The dust then becomes host to germs and if enough of the right kinds are present, there is danger of contagion.

Medical research in recent years indicates that atmospheric dust under ordinary conditions is not so dangerous to health as was once believed. Dr. Samuel C. Prescott, '94, and Dr. Murray P. Horwood, '16, in their recent revised edition of "Sedgwick's Principles of Sanitary Science and Public Health" recall that at one time the danger of atmospheric infection was considered so great that the air of operating rooms in hospitals was disinfected with carbolic sprays. The practice has been abandoned in favor of aseptic surgery, because the danger of infection from the atmosphere is considered remote. Nevertheless, the air of operating rooms is frequently washed today to remove most of the dust particles and bacteria present. In consequence of the newer and sounder knowledge of the significant sources and modes of infection, the old and terrifying pesthouse, which once stood in gloomy isolation on the outskirts of almost every community, has been replaced by the modern hospital for communicable diseases. Often it may be found in the very heart of a congested district.

Concerned as it is with the effects of all dust, science, particularly in the fields of public health and medicine, is interested in the many complex dust forms produced in industrial processes, which include products of combustion and chemical processes, as well as mechanical operations in which abrasion occurs. Dust is one of the most widespread and dangerous occupational hazards to which much attention has been given in recent years. It was in 1914 that the United States Public Health Service, working in coöperation with the Bureau of Mines, began a study of workers subjected to dust in the lead and zinc mines of Missouri. Later studies were made in a cement mill, a granite cutting plant, a cotton textile mill, a municipal street sweeping department, slate, granite, marble, and talc quarries, as well as a silverware manufacturing plant, anthracite mines, and sand-blasting operations. The studies showed that workers in certain of these fields were subject to various diseases, including tuberculosis, silicosis, anthracosis, and pneumoconiosis; but the workers in the silverware plant and the municipal street sweeping department showed no marked tendency to respiratory diseases.

In all these studies investigators were constantly concerned with the quantity of free silica present in the various forms of dust. In "Preventive Medicine and Hygiene," Dr. Milton J. Rosenau, former director of the School of Public Health of Harvard University and Technology, says that from the evidence gathered on the injurious effects produced by inhaling dust it is apparent that knowledge of the properties of a given dust is essential. "Numerous investigations of the industrial dust problem," he adds, "indicate that these properties are the chemical and mineralogical composition of the dust, its concentrations, and its particle size." The latter consideration, Dr. Rosenau finds, is of great importance, for the examination of silicotic lungs has revealed that virtually all the dust particles are less than 10 microns in their longest dimension. Apropos of this observation it might be noted that studies have shown that the average size of dust particles in the working atmosphere of many industries is smaller than 10 microns, while larger and heavier particles apparently settle quickly and are not found in large numbers.

Although much progress has been made in overcoming the hazards of dust in industry, a great deal remains to be done. Dr. Rosenau finds that there are many industrial dusts about which little or nothing is known. Among these he cites tripoli, a free silica composed of quartz and amorphous silica, vitreous quartz, the dusts of the foundry and ceramic industries, as well as pure talc and soapstone from which it is manufactured. New industries produce new and complex dust forms, recruits to that vast community of floating particles that fill the atmosphere and travel great distances at the will of the winds. The industrial hazards of dust probably

never can be completely eliminated, but eventual control of its injurious effects in many fields may be expected.

Salmon Engineering

GREAT engineering projects often create unforseen problems wholly unrelated to their main objective: Such is the case at Bonneville. The graceful Chinook salmon who yearn for the upper tributaries of the Columbia River will find that a 72-foot wall has been raised between them and the glacier-cooled waters they seek. Not for humanitarian reasons alone is it necessary to aid these 20- to 30-pound swimmers of currents: If they die without spawning we will be faced with the loss of a $10,000,000 industry.

After several years of brow wrinkling, the biologists of the Bureau of Fisheries in coöperation with the conservation authorities of Washington and Oregon and the Army engineers have decided on the installation of a stairway and an elevator. At each end of the dam a stream of water moving at the rate of 1,000 cubic feet a second is planned to attract the salmon with his avidity for swiftly moving waters and thus lead him into the collecting system. On the right he will find the stairway: a series of 16-foot pools placed at intervals of one foot — child's play for the salmon to ascend. On the left — "watch your step, please" — the lifts may be found. The elevators, or fish locks, are 20 feet by 30 feet. "Entrance gates 10 feet square will discharge 200 cubic feet of water per second, as an inducement to the fish to enter the locks. Once the fish are inside, the entrance gates will close, and the water will be admitted through the floor of the lock chamber to raise the water level to that of the top of the dam. The 'elevator' itself rises with the mounting water, and when the exit level is reached the gates are opened and the fish speeded on their way by the device of tipping the floor and spilling them out into the river above the dam. Two fish locks will be in operation at the same time; while one lock is ascending, the other will be receiving fish below." Downstream traffic is composed of youngsters only and it is expected that the stairway will be their means of descent. It is possible, however, for the small fish to pass unscathed through the large openings in the power wheels.

For the salmon hatched in the plateaus of eastern Washington, 150 miles from the Canadian border, the entire problem has thus been solved. There are many, however, whose urge is to travel into tributaries now being cut off by Grand Coulee. This 500-foot barrier thwarts all suggestions of circumlocution. Here the biologists plan to build a collecting trap in the river and holding pools in the canyon nearby. Special troughs will be built for artificial hatching of the eggs with pick-up and delivery service maintained to return the youngsters to the stream. An attempt may even be made to remove the fertilized spawn to tributaries which will be accessible to the returning adult salmon.

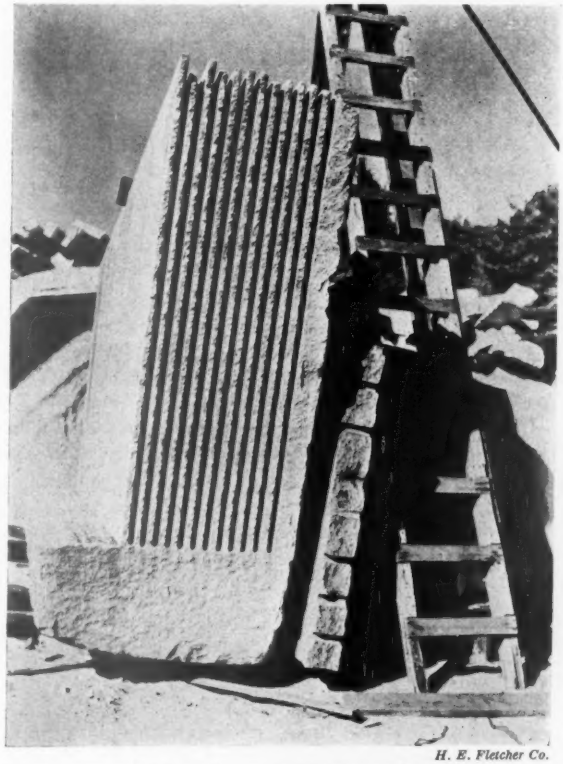
With so much planning for their welfare it is a relief to know that the salmon will not have to face the difficulties encountered by Darwin's alleged herring. You remember that belief in the relation between functional need and organic development led Darwin to teach his fish to live in the air. The herring accompanied him on morning strolls, led with a blue ribbon, until Darwin absent-mindedly crossed a bridge on which the planking was too widely spaced, and the poor little herring, awkwardly following, fell through and was drowned.

Patents by the Century

THE United States Patent Office this year celebrates its centennial, for it was on July 4, 1836, that the American patent system of regular official search was started. In the century of its history, civilization has marched forward with seven-league strides and the milestones of its progress include many of the most important inventions of all time.

The phosphorus match was invented in the year of the founding of the bureau and next in the list of American inventions came Hiram Moore's harvesting machine and Charles Goodyear's method of vulcanizing rubber, while in Europe Daguerre and Niepce developed their method of photography. The pneumatic tire, the turret lathe, the rotary printing press, and the sewing machine — all American inventions — came in the first decade of our patent system. Then followed the hydraulic turbine and the humble but indispensable safety pin.

In 1851, just 15 years after an act of Congress inaugurated for the first time in history "a methodical examination for novelty in advance of the grant of a patent," Vail invented the electric locomotive. A year later Otis produced an elevator that could be braked,



H. E. Fletcher Co.

By a new method granite can now be thus cut into thin sheets

Triangle

The leaping concrete arches of the Arroyo Street Bridge, Pasadena, Calif.

and it is recorded that two years later Walter Hunt gained undying fame by giving mankind the paper collar. Steel was invented in 1857, to be followed by the building of the *Monitor* and the invention of the machine gun within five years. The mowing machine, the web press, railway block signals, typewriters, lawn mowers, air brakes, celluloid, telephones, talking machines, Professor Elihu Thompson's method of electric welding, Edison's incandescent light, and Brush's arc light followed.

Trolley cars came in 1884, and four years later George Eastman and the Rev. H. Goodwin invented the transparent photographic film. Then quickly in the succeeding years came such important inventions as the alternating-current motor, Edison's motion-picture machine (which followed Seller's invention by 32 years) the submarine, and the gasoline automobile, radio sending apparatus and the radio telephone in 1902, the motor-driven airplane a year later, and the seaplane in 1911. Radio vacuum tubes were invented in 1907 and the important synthetic resin industry of today had its beginning in L. H. Baekeland's invention of 1909.

During this period European inventors had contributed Portland cement, the gas stove burner, aniline dyes, the electric furnace, dynamite, the Otto gas engine, manganese steel, rayon, the steam turbine, smokeless powder, Lumière's moving-picture projector, low-frequency wireless telegraphy, the Diesel oil motor, photography by wire, nitrogen fixation, and the helicopter.

At first the granting of patents in this country was placed in the hands of the Secretary of State, the Secretary of War, and the Attorney General. When Thomas Jefferson was Secretary of State he personally examined many petitions for patents; but by the Act of July 4, 1836, the Patent Office was established under a commissioner; and on March 3, 1849, when the Department of the Interior was established, the Patent Office was placed under its jurisdiction. In 1925 it was transferred by President Coolidge to the Department of Commerce.

The first patent granted under the original law was to Samuel Hopkins of Vermont, July 31, 1790, and was for a process for making potash and pearlash.

Between 1790 and July 28, 1836, a total of 9,957 patents were issued, and between 1836 and 1850 the number was 6,980. By 1918 the number in a single year had mounted to 38,569. Letters patent for 1934 numbered 48,523, and for 1935 there were 41,621. Here it is of interest to note that the number of patents *per capita* in this country has not increased in over half a century. It has been estimated that of all industrial enterprises, seven eighths are dependent directly or indirectly upon our patent system, or owed their being originally to the patent law.

Book of the Month

*As books on science and engineering are published The Review appraises them and selects for comment those which are important or those upon which we feel our readers would welcome authoritative judgment. This month Philip Morse reviews on the next page "New World Picture" * by George W. Gray.*

* Boston: Little, Brown and Company (The Atlantic Monthly Press), 1936. 402 pages, $3.50.

Bureau of Reclamation

Prelude to dynamite. Drilling squad on east abutment of Grand Coulee Dam. This $63,000,000 project will require 14,400,000 cubic yards of excavation

GEORGE GRAY is to be congratulated on having written a popular, nonmathematical book on modern physics which does not mix science with religion and amateur philosophy. I consider his book to be one of the best I have read in the past several years.

The time is ripe for books like "New World Picture." Physics has just emerged from a ten-year struggle with the problem of atomic structure, and is at present enjoying a short breathing space before attacking the mysteries of the nucleus. During the struggle, many beautiful theories had to be discarded and many concepts changed, but the result has been greater unity and a tremendous advance in our understanding of the nature of things. By means of the present theory we are able to work out the chemical and physical relations between atoms and molecules and crystals. There are, of course, many problems still untouched; but these are mainly concerned with applying the general theory to specific cases. They are more of the nature of detailed investigation than of frontier exploration. In another ten years or so physics will be engaged in another struggle with the problem of the nucleus. The battle will probably be on as wide a front as the atomic one, now nearly finished. As many theories will have to be modified in explaining the nucleus as were changed by the concepts of the quantum theory; but before this struggle begins we now have a short lull in which to consolidate our position and to survey our present knowledge.

"New World Picture" is an excellent example of a survey of the present physics. It does not confine itself to the more romantic and less fundamental parts of our knowledge, but it tries to give a connected picture of the whole field. The first half of the book concerns itself with new developments in astrophysics. It reports the recent findings about the shape and size of the universe and our state of knowledge of the evolution of stars. A section is devoted to the rôle general relativity has played in clarifying this knowledge; but Mr. Gray rightly places relativity in a subsidiary position in the general astronomical picture. He spends as much time on the constitution of star clusters as on the curvature of space. It is a pleasure to see a popular book with a proper perspective in such matters.

Young and Phelps

Unloading an ore boat at steel plant

Young and Phelps

Continuous treating plant for purifying gasoline

The second half of the book concerns itself with atomic physics. Here the subject matter is more difficult of exposition than that of astrophysics, though it is just as exciting. Mr. Gray has been fairly successful in conveying the fundamental ideas in simple language. In a few places, notably in the section on waves of probability, the reviewer believes that a simpler, more graphic picture could have been presented; but on the whole the exposition is as clear as the complexities of the subject allow.

Probably the most important group of ideas which a writer of popular science must convey is that concerned with the *method* of science: the way a scientist goes about understanding new phenomena. It is this scientific method which endures even though theories are modified and discarded; it will be science's most valuable contribution to human progress. Mr. Gray brings out the method of science by treating his subject in an historical manner. He discusses the problems that confronted physics in the 1900's and shows how they were solved, one by one — only to bring forth new problems. He emphasizes by numerous examples the necessarily

tentative nature of all scientific theories, and illustrates how valuable these theories can be even though they are tentative. More books should be written on this subject, for it is the most important thing science has to teach the layman. One can hope that sometime the scientific method can be used even in social and political problems.

It is a sign of America's scientific maturity that several excellent semi-popular books on physics have been issued in this country in the past year. Harvey Lemon's

Ralph P. Johnson

Photomicrograph of coil filaments from a 25-watt tungsten lamp

"From Galileo to Cosmic Rays," and Lindsay and Margenau's "Foundations of Physics" are indications that American physicists are beginning to look beyond the narrow limitations of their individual specialities to view science as a whole. Mr. Gray's more popular book is a further indication of this trend. Let us hope there will be more like it.

Brine

GREAT SALT LAKE, the residual of prehistoric Lake Bonneville, last autumn was at its lowest level in recorded history due to five years of drought, with the result that the salt content reached the saturation point of 22.4% and crystals seized upon any immersed object to find a permanent mooring place.

On the next page, for example, is a photograph of the results produced upon a model passenger locomotive, for which illustration The Review is indebted to Walter H. Trask, Jr., '06, as it is also for the information that the run-off from heavy snows in the mountains this past winter has already caused a rise of about a foot in the lake level, thus beginning the cyclical variation anew.

Originally Lake Bonneville covered an area of almost 20,000 square miles and extended into Nevada and Idaho. Its greatest length, north and south, was 346 miles, and the greatest width, east and west, was 145 miles; its mean depth was 800 feet. Its shore lines, distinctly traceable on the mountainsides about 1,100 feet above Great Salt Lake, indicate that Lake Bonneville originally was but slightly smaller than Lake Huron with a shore line of over 2,500 miles. Some 600 feet above the present lake may also be traced the outlines of what is known as the intermediate, or Provo level, to which it is supposed Lake Bonneville receded when its waters broke through Red Rock Pass into southern Idaho to pass through the Snake and Columbia rivers to the Pacific. This recession, it is estimated, took place during a period of about 25 years.

With an annual evaporation of almost seven feet over the present area of about 1,700 square miles, Great Salt Lake, although it has no outlet, naturally drops in level and increases in salinity when a deficiency in natural precipitation causes the Jordan, Weber, and Bear rivers to fail to supply the lake with sufficient fresh water. Its current brininess is strikingly illustrated by the fact that a Douglas airplane lost in its shallow waters last October became salt encrusted and was discovered only months later by dragging midway between Stansbury and Antelope Islands about 22 miles north of Black Rock. Another of Mr. Trask's photographs on the opposite page shows the salvaged plane being hoisted from the water by a railroad crane to be loaded for shipment to California for examination.

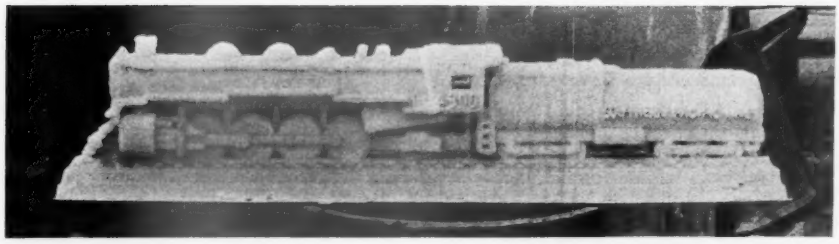
Cancellations

TWO weeks before Christmas of last year a ten-year-old boy was taken, an emergency patient, to a New York hospital. He had been playing football, had been struck by an automobile, and had been left lying un-

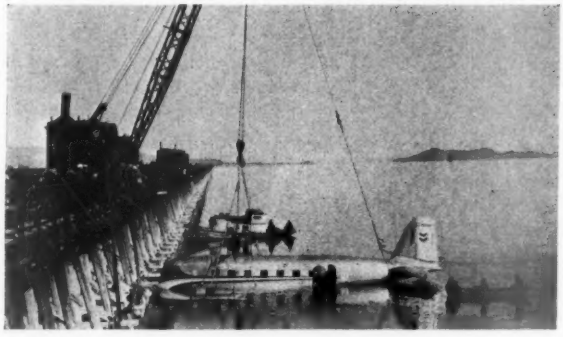
F. S. Lincoln, '22

Long Island week-end house of A. Laurence Kocher, '13, designed by himself. The main portion of the house is canvas covered; the small addition on the left has a steel frame with terra cotta veneer and glass brick windows

SALINITY: 22.4%
Right. *Salt-frosted model locomotive after immersion in Great Salt Lake*



Below. *Salvaging the airplane lost in Great Salt Lake last October. When found it was encrusted with salt. See opposite page*



conscious in the street, his brain exposed where part of his skull had been torn away. Doctors expected him to live but a few hours. Three months and a half later he was released from his hospital room, sound and normal though still subject to periodic changes of dressings. Infection of the exposed surface of his brain, with probable consequent meningitis, had been averted by means of irrigation maintained constantly for a period of weeks; a new covering had formed over his brain — though the opening torn in his skull by the impact of the car still remained. It is expected that new bone will close this hole within a few years; if it does not, a silver plate may be inserted.

This phase of the boy's case points vividly to advances which have been made in emergency hospitalization, in antisepsis, in surgery, and in medical science. The inanimate and consequently blameless machine responsible for his nearness to death may be considered the second phase of the case, and is the product of comparable advances in invention, in manufacture, in engineering, and in the development of resources.

Two more aspects, however, remain in this case and in all others similar to it. They point to no progress; rather, if indeed they do not indicate backslip, they indicate stagnancy. The fact that the boy was playing his game in the street intimates that he had nowhere else to play. The operator of the machine which ran him down went uncaught and unpunished. That engineering which manipulates humankind and which we call political or social is obviously deficient.

In the driver who stepped on the gas and scuttled out of sight after the crunching instant, the sense of ethical or social responsibility or ordinary human decency could have had little more, if not less, vitality than it had in the days when the unwanted child was knocked on the head by its own father. If we consider the development of ethics comparable to science in its delicacy and its selflessness, the human science involved in this case is likewise a weak and faulty thing.

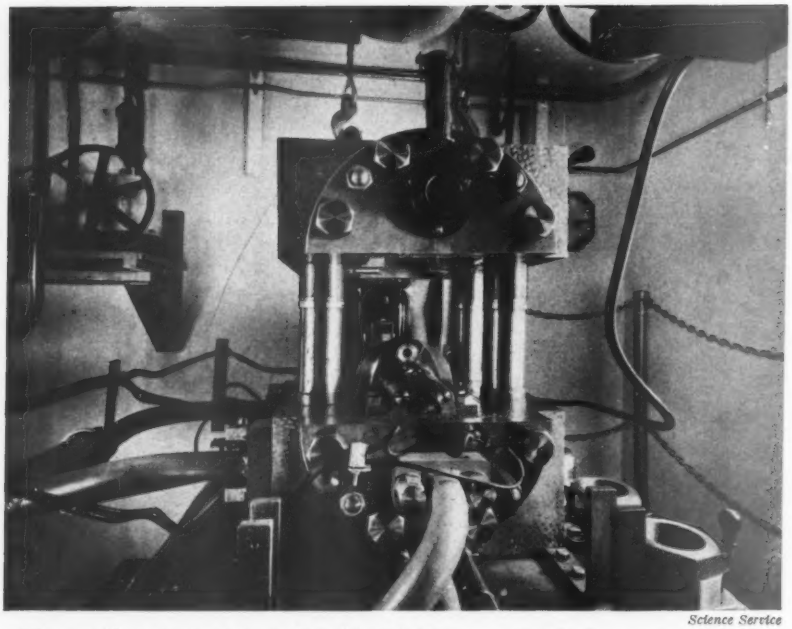
It is ironic refutation of aspiration for the achievements of the race in the first two fields that it be nullified by consistent failure in the others. If that nullification is to be allowed unchallenged, the achievements may become no more than palliatives of evil.

Vignettes

THE Firestone Rubber Company is experimenting with a rubber spring for automobiles that works somewhat like a bellows. The device consists of two

Science Service

The new "peanut" light (left), developed by the Westinghouse Lamp Company, is claimed to be man's brightest source of light. A small globule of metallic mercury, in a tiny quartz tube about the size of a roasted peanut in its shell, vaporizes when submitted to an electrical discharge, and sets up a brilliant glow of light similar in color composition to that of sunlight. Dr. John W. Marden, Westinghouse research scientist, is comparing its light with that of a replica of the original carbon arc light developed by Sir Humphry Davy in 1813, (center) and a replica of Faraday's original mercury arc light dating back to 1835



Science Service

Ultracentrifuge, developed by the Swedish Nobel Laureate, Thé Svedberg, now in use industrially by the Du Pont Company. It whirls solutions with forces equal to 250,000 times the force of gravity. In the photograph the upper part of the housing has been removed to show the rotor, cell chamber, and bearing

rubber units connected by a hose to an air reservoir, and air movement between the spring and the reservoir cushions road shocks. Rubberized fabric is used in the units, which are reported to have passed, successfully, a test of 8,000,000 two-inch deformations under a heavy overload.

¶ The Thiokol Corporation of New Jersey reports development of a molding compound of synthetic rubber which may be formed as easily as phenol and urea resins. It is said to be fully vulcanized in the molded state.

¶ Carl Zeiss announces a new method of examining colorless objects under a microscope, a process which has always been difficult because of lack of contrast between the object and its background. A new device called the micropolychromar, which employs a diaphragm mechanism and colored filters, now makes it possible to color objects optically.

¶ In Germany one of the large engineering organizations is building for the German National Railways a motor car to be driven by steam from a boiler capable of generating pressure at 1,400 pounds to the inch. This system, which is called the Borsig drive, uses a steam motor, the details of which are not revealed. On the highways of Germany and France the Oberhaesli crude-oil motor appears to be gaining popularity as a power plant for pleasure automobiles. A French car was recently driven 15,000 miles with a crude-oil consumption of less than four gallons per hundred miles. Fuel costs are said to be reduced from 60% to 75% under those of gasoline.

¶ The old problem of treating sea water for use in boilers and for other industrial applications is being attacked by the National Physical Laboratories of England by a new method. The salt water is first passed through tubes composed of synthetic resin made of tannic acid and formalin. The tubes absorb into their walls all basic metallic or alkaline elements. After this treatment the water is passed through tubes made of formalin and aniline, which remove acid-forming chemicals.

¶ Limestone in colors such as red, purple, lilac, brown, and green may soon become common as interior decoration, for a process of impregnation has recently been developed which will make possible such coloring of this building material.

¶ A new instrument which should be invaluable to those engaged in the study of metals has recently been built. It is called a dilatometer and is capable of recording and measuring in ten thousandths of an inch the expansion and contraction of metals as they are heated and cooled.

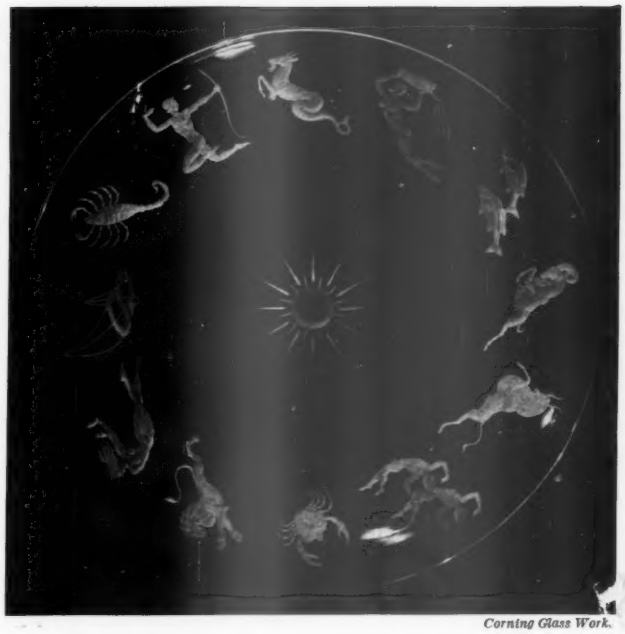
¶ The Owens Illinois Glass Company is reported to be drawing fibrous glass for textile purposes at a speed of 50 miles a minute. A pound of glass can be drawn in a single fiber to a length of more than 25,000 miles. This strand is reported to be one twentieth of the diameter of a human hair, so fine that more than 100 would be required to equal the size of ordinary sewing thread. Incidentally, the speed of drawing the fiber is five times that of the flight of a Springfield rifle bullet.

¶ The Vermont Marble Company announces a method for bringing out the natural internal beauty of marble: The product is Lumar, a scientifically selected and specially processed marble which provides beauty and light in an entirely new form. Ordinary electric light bulbs are used as the source of light, but since the marble is translucent, high wattages are not necessary. The surface illumination of Lumar is never spotty nor uneven.

¶ Two new products recently placed on the market should make life a little pleasanter for those who have to do much walking indoors. One is a nonslippery floor wax whose novel characteristic is a "higher coefficient of friction." This quality is said to make it much less slippery than ordinary waxes and is obtained by adding approximately 10% of high-grade, light-colored raw rubber to the mixture of beeswax and carnauba wax used in making most floor waxes. The other new flooring material already has a trade name — Permex. Floors covered with it can resist indentation from the heaviest loads of furniture and the other advantages claimed for it are that it is nonabrasive, does not absorb oils or stain easily, does not become sticky or rough, and is not at all affected by lighted cigarette butts. Permex is made from the bark which has long been an unused by-product of paper manufacturing.

THE ZODIAC BOWL

Right. *Adding to the laurels which he has won in the field of sculpture, Sidney B. Waugh, '27, three years ago undertook designs for Steuben glass. Of the many noteworthy engraved pieces which he has since executed, one of the most famous is the Zodiac Bowl which is now in the permanent collection of both the Metropolitan Museum of Art in New York and the Victoria and Albert Museum in London. The bowl derives its name from the twelve signs of the Zodiac which form a continuous band of decoration around its circumference*



Corning Glass Work.

THE GAZELLE BOWL

Below. *Another example of Sidney Waugh's beautiful glass designs is the Gazelle Bowl, a replica of which has been purchased by the Metropolitan Museum of Art in New York. The bowl rests on a base of solid crystal in the form of four flanges joined at their intersection. Twelve leaping gazelles decorate the bowl, each antelope representing a different phase of the jump. The transparency of glass, which permits both sides of the bowl to be seen simultaneously, gives an illusion of movement not obtainable in any other medium*

Science and the Fine Arts

Does Technical Education Debase Esthetic Appreciation?

BY RALPH G. HUDSON

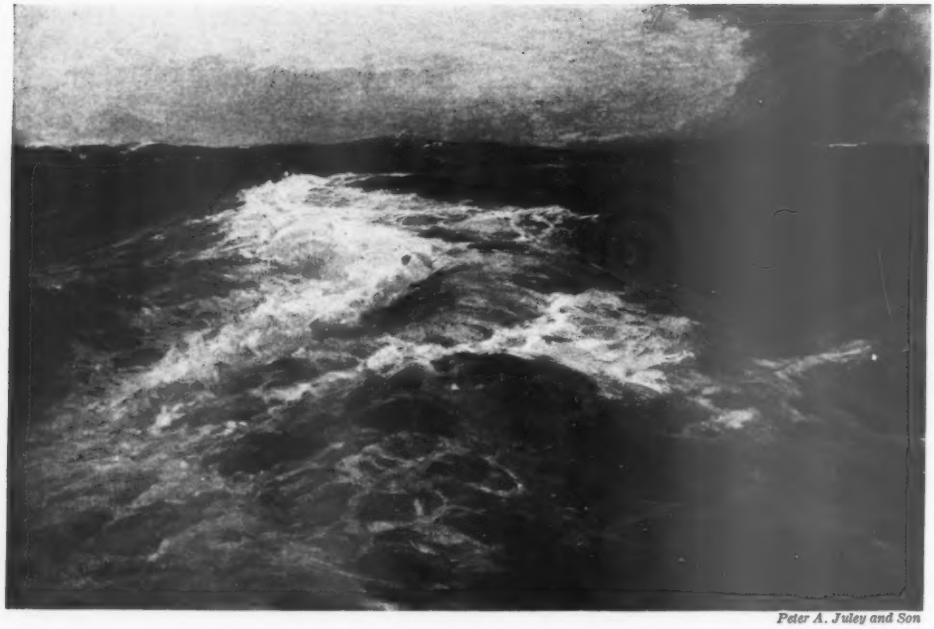
ONE of the unfortunate consequences of modern specialization is the traditional assumption in one group that no other group may be expected to comprehend its aims and ideals or make an important contribution to its field of activity. History indicates no such compartmental limitation of genius. Leonardo da Vinci was probably the greatest engineer of his period and at the same time a master of classical painting. Thomas A. Edison hung on the wall of his office a single framed aphorism which said: "There is no expedient to which man will not resort to avoid the real labor of thinking." The author of this inspiration to Edison was Sir Joshua Reynolds, the eminent English portrait painter. Charles L. Dodgson was known at Oxford University as a professor of mathematics but is known to the world at large as Lewis Carroll, the author of "Alice's Adventures in Wonderland."

Although progress in science is a highly imaginative process, science itself is too often associated with materialism by the laity. Many times it has been represented as incompatible with religion and culture. With the inference that the world has suffered from its activity, science has been urged to take a holiday. It has been cited as the cause of industrial revolution and has frequently been given the sordid credit for the cruelties of warfare. In spite of the impressive beauty of a bridge, a cup defender, or an ocean liner, science is not generally associated with the esthetic works of man. The fine arts are usually considered to be beyond the pale of the scientist because it is assumed that he lacks constitutionally the fundamental emotional impulse.

Corning Glass Works

Until recent times the fine arts formed a rather exclusive club. There were only five members in good standing: architecture, sculpture, painting, music, and poetry. Auguste Comte, the French philosopher, not only restricted their content, but insisted that the order should be arranged, as stated, to indicate their increasing importance. Our confidence in his infallibility may be shaken somewhat by another of his dictums in which he said: "There are some things of which the human race must forever remain in ignorance; for example, the chemical composition of the sun and the other heavenly bodies."

The general definition of a fine art is any production of man which possesses beauty; it may or may not have a useful purpose but must first create an emotional sense of delight.



Peter A. Juley and Son

MID-OCEAN

Illustrative of the sea paintings of Charles Herbert Woodbury, '86, is this one with its realistic mid-ocean waves. The artist is one of several Technology graduates who have distinguished themselves in the field of painting. Mr. Woodbury has written several books on the subject of painting and his pictures have won many medals and prizes

The complete definition must include many other fine restrictions. The sense of beauty, for example, must enter the brain either through the optic or the auditory nerve. No matter how beautiful an *hors d'œuvre* may be, it cannot be hung in exhibition because it is made essentially to please the taste. The originator of a new exotic perfume will win no more *médailles de beaux arts* than the owner of a pigsty. There is, of course, considerable diversity of opinion as to the specification of beauty. Somebody has said that "beauty is in the eye of the beholder." In architecture, many devotees of the fluted column have not yet bowed to the radiator fins. In painting, the sunflowers of Van Gogh and the cubistic "Nude Descending a Staircase" may provoke opposite impressions. In music, the admirer of the Beethoven "Fifth Symphony" may not be thrilled by the "Soviet Iron Foundry." The effect of poetry is always a gamble. Some prefer to breathe deeply with "Horatius at the Bridge" while others must wander through "The Garden of Proserpine."

There are two important questions to be raised regarding the popular opinion of the relationship between science and the fine arts: The first is whether a scientific or technical education inhibits or debases an appreciation of the fine arts; the second is whether science in itself is noncoöperative in the development of the arts.

It would be difficult if not impossible to measure the relative esthetic propensities of the graduates of liberal arts colleges and the engineering schools. Since "creating and not possessing is the essence of culture," it should be more convincing to examine the accomplishments of some of our own former students and determine from that record whether a technical education may be expected to restrain all interest in the fine arts. It is furthermore intended to exclude all transfer students. Much as we appreciate their influence, it will be more significant to include only those Alumni who began their college training at the Institute.

In the realm of architecture there are few communities in the country in which the sky line is not blocked out to some degree by the hand of one of our graduates. The preëminence and accomplishments of our School of Architecture are too well established to require detailed elaboration. It is, moreover, a field in which an appreciation of the fine arts is to be expected.

With reference to sculpture the best known statue in the Harvard Yard is that of John Harvard. This was done by the late Daniel Chester French, '71. This is an achievement, and the difficulty of its execution will be better appreciated if it is realized that nobody knows what John Harvard looked like. Other well-known statues produced by French are the Minute Man of Concord, the Alice Freeman Palmer Memorial at Wellesley College, General Cass (in the National Capitol), Rufus Choate (Boston Courthouse), and the Statue of the Republic (World's Columbian Exposition). Darragh de Lancey, II, '90, after retiring from a successful career in business, has turned his attention to sculpture. His best known productions are Exedra at Great Barrington, Mass., and the War Memorial at Newtown, Conn. Sidney Biehler Waugh, IV, '27, won the *Prix de Rome* for sculpture in 1929, and was awarded the prize exhibit in the 1934 salon of American handmade glass.

In the field of painting, Charles Herbert Woodbury, II, '86, is an eminent painter of sea pictures and is unsurpassed in his paintings of ocean waves. He has received 20 medals and prizes for paintings and etchings and is the author of several books on painting. Philip Little, IX, '79, has received many medals and prizes in various exhibitions. His paintings are included in the permanent collection of several museums and art galleries throughout the United States. Edwin Howland Blashfield, '69, has painted murals and ceilings in many state capitols, courthouses, churches, colleges, private homes, and our own Walker Memorial. His decoration

Courtesy Goodspeed's

"Summer Street, Marblehead" is one of the latest drypoints done by Samuel V. Chamberlain, '18. Since returning to this country from France, Mr. Chamberlain has been giving a course in the graphic arts at M.I.T.

of the great central dome in the Library of Congress is well known. He ranks among the greatest of the mural decorators in America. Charles Bittinger, '01, has been honored by many medals and prizes for his paintings, and Isaac Brewster Hazelton, IV, '94, is a prominent painter of portraits. Edgar Irving Williams, IV, '08, is a prominent architect who has also won distinction as a water colorist. Joseph Paul Gardner, IV, '17, is the director of the Nelson Gallery of Art in Kansas City. Among the Alumni of our School of Architecture are several men who have received wide recognition as etchers of unusual merit. To connoisseurs of fine etchings perhaps the best known are: John Taylor Arms, '11, Samuel Vance Chamberlain, '18, Louis Conrad Rosenberg, '13, and George Canning Wales, '89.

In the realm of music Arthur George Farwell, VI, '93, has been a lecturer in music at Cornell University, the University of California, and Michigan State College. He has composed American Indian melodies, vocal and orchestral music for pageants, and has directed concerts and musical festivals throughout the country. The late Frederic Field Bullard, '87, was a transfer from Dartmouth and is mentioned here, rule or no rule, because all Technology men acclaim him especially as the composer of "The Stein Song."

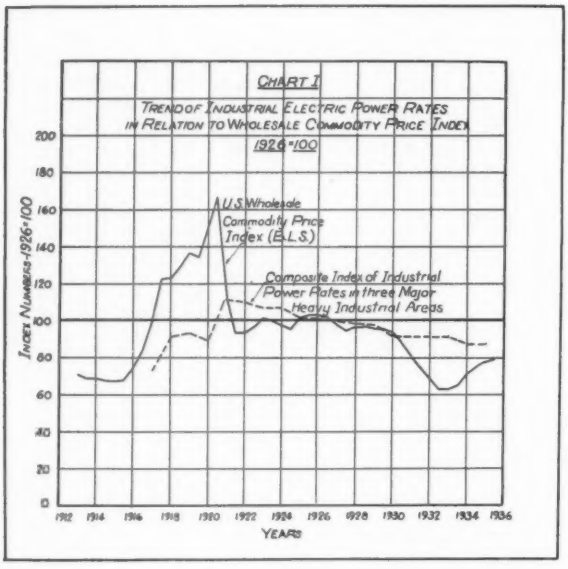
In his recent autobiography, "And Gladly Teach," Bliss Perry says that it "was once remarked of a venerable Oxford don who refused to retire, that he had all the Christian virtues except resignation." This cannot be said of our Alumni with reference to their production of poetry. There are poets among the Alumni, but whether their virtues be resignation, modesty, or humility, their collections are peeked at only on rare occasions by close friends. The public is probably most familiar with the whimsical poetry of Gelett Burgess, I, '87, especially the one that begins:

"The Goops they lick their fingers,
And the Goops they lick their knives."

Although not included in the old classification, the modern concept of the fine arts includes the higher forms of prose. Allen French, IX, '92, has published 21 volumes of fiction and for six years was an instructor of English at Harvard University. To those who appreciate the anomaly, this might be called the reverse English. Gelett Burgess (mentioned above as a poet) is the author of more than 30 books and plays. Francis Russell Hart, VI, '89, during a busy career as a banker, has written three captivating volumes relating to the early history of the Caribbean. The late Arthur Dehon Little, V, '85, gained a host of admirers through his brilliant contributions to the *Atlantic Monthly*. The late Charles Russell Richards, II, '85, was the author of various books on industrial art and received the gold medal of the Architectural League of New York in 1936 in recognition of his service to the arts of decoration. Stuart Doane Chase, IX, '10, although writing in the field of economic research, has attracted a wide circle of readers by 12 popular books which are distinctive for their vigorous literary style. Irving Fineman, I, '17, is a professor of English and American literature at Bennington College and is the (*Continued on page 356*)

One of the landmarks of the Harvard Yard is this statue of John Harvard which is the work of the late Daniel Chester French, '71

Keystone



The Story Behind

Facts and Fancies

BY MALCOLM

Editorially The Review eschews any stand on the question of public versus private ownership of public utilities. It nevertheless welcomes the opportunity to present the following discussion, by a rate expert, of the factors which determine electric rates, the trend of these rates, and the economics of "yardstick" systems. — THE EDITOR.

RECENT agitations concerning rate levels in the electrical industry have been built around the allegation that the charges are too high for the service rendered and that this condition has largely developed as a result of the absence of competitive influences which, if present, would automatically act to reduce these prices. From this premise there has developed the philosophy of governmental construction and operation of competing utility systems, euphemistically called "yardstick" plants because they are supposed to present a measure of the cost of electrical service. A second premise is that lower rates will result in wide increases in the use of energy which, in turn, will materially improve the standard of living.

The yardstick movement has an undeniable appeal, particularly to those who see in it a means by which a few dollars may be pared from the electric budget and transferred to the movie, the cigarette, or the gasoline budget. This appeal is made to the superficial opportunism that exists in a large majority of persons. Can, however, such a program be justified upon the ground of lower costs?

Let us look at the record. Yardstick municipal plants are being constructed on the basis of Federal financing, with from 30% to 45% of the investment conveyed as a grant. Is this a proper yardstick with which to measure the costs incurred by private capital in rendering the same services? Not only must private enterprise finance the full investment in plant, but it must also pay taxes which, in 1934, amounted to approximately 14% of the total revenue received. If investment grants must be given and a portion of existing tax revenues waived (due to the elimination of private enterprises) in order to make governmental operation a success, it is apparent that the so-called success achieves its short-lived existence through an ultimate increase in the general tax burden.

The premises upon which the supposed necessity for governmental operation of utility services are predicated should be given thoroughly objective consideration. If they are nonexistent, and if the past history of governmental operation does not indicate success in achieving costs lower than private operation, it can be assumed that motives other than sound economic principles form the basis for the agitation. If economic justification is absent, the alleged power yardstick becomes, in fact, not what it has been termed by one protagonist of governmental operation, a "birch rod" with which to chastise a "naughty" industry, but a very real and very dangerous club being wielded with reckless abandon.

The Effect of Competitive Influences

The rendering of utility services forms a business that is properly classified in the category of "natural monopolies." Units of the industry are most economically operated as monopolies, within each individual's sphere of operation. This is a natural development of the fact that extremely heavy investments are required per unit of revenue, which investments under normal conditions generally range from five to seven times the annual revenues. Duplication of a large portion of the physical structures develops if more than one unit serves the same customer group. The result of such duplication is either higher costs or eventual bankruptcy through "cut throat" competition; either alternative results in economic waste.

Too frequently the monopolistic nature of utility operations leads to the assumption that the industry is not subject to competitive influences. This conception is far from true even though there usually exists no direct competition between units serving the same commodity. While this latter form of competition, *i.e.*, that existing between price for and quality of an identical article or service, is largely absent, there are other more subtle forms of competition, the incidences of which have a very definite effect upon the price structure of the industry. The competition that is offered by other methods of obtaining results identical to those that can be secured from electric service and the competition of entirely different services and commodities for a share of the prospective customer's dollar form the two major competitive influences. Of lesser importance and applying generally only in the sale of electric service to industry are the competitive influences offered by location with respect to markets, labor, and raw materials, and by the price structures of adjacent systems. These latter

Your Light Bill

about Electric Rates

G. Davis

two are of a rather specific nature and vary greatly with each particular instance.

These several competitive influences have two diverse effects upon rate levels. One is the natural reaction of price pressure which tends to bring rates lower as markets are expanded, while the other acts to inhibit, in individual instances, the further reduction of rates due to the existence of economically unassailable competitive barriers raised by other methods and forms of rendering the same services. By "economically unassailable" is meant that the service would have to be rendered at less than cost in order to meet the price of equally good competitive services. Competition under such conditions is economically unsound.

The most easily evaluated form of competition is that which exists in the field of large industrial power sales where the application of central station service is controlled largely by the competitive levels set by the costs of operating industrial generating plants. These competitive values to a major degree determine the level of industrial power rates. It is to be expected, therefore, that the level of industrial power rates will vary within a pattern determined by the cyclical changes in the general price structure. This condition is evident from an inspection of Chart I, which shows, in index form, the trend of industrial power rates in comparison with the United States Wholesale Commodity Index as prepared by the Bureau of Labor Statistics.

Because many of the costs entering into utility operations are relatively fixed, and the balance is not so volatile as are a majority of the components of the general price structure, the fluctuations in industrial rate levels will not be so violent as those occurring in the index of wholesale commodity costs. This fact is borne out by the results recorded on Chart I. Thus, wholesale prices increased nearly 150% from 1913 to 1914 levels to the 1921 maximum; industrial power rates increased only 60% in the same period.

A high degree of inertia to rate changes resulted in a somewhat slower decline from peak rate levels to those of 1925 to 1928. Inertia to change, however, was itself the result of certain basic causes. Thus, many of the cost components of utility service did not decline so rapidly as did the general price structure; also investments incurred at the time of peak prices were still on the books exerting their influence upon rate levels. These same factors controlled the trend of competitive costs so that competitive pressure did not immediately increase in direct proportion to the decline in the general price structure.

During the period 1929 to 1933 when the general price structure collapsed, industrial power rates did not decline proportionately. Two factors exerted a definite influence during this period, the more important being

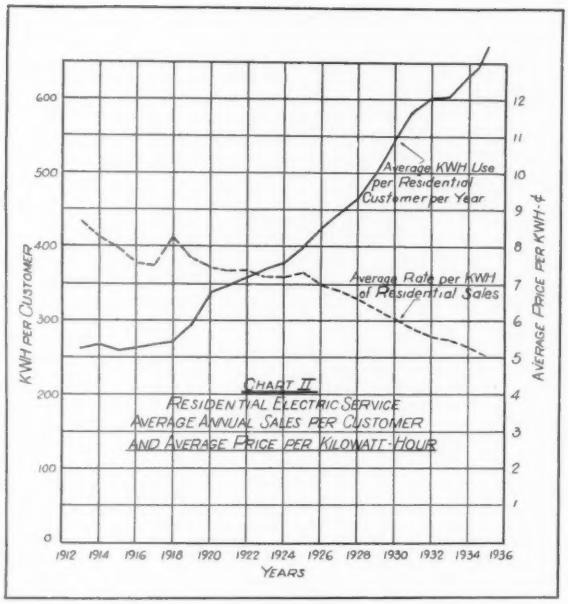


CHART II
RESIDENTIAL ELECTRIC SERVICE
AVERAGE ANNUAL SALES PER CUSTOMER
AND AVERAGE PRICE PER KILOWATT-HOUR

that there was little or no new load to be obtained and the other that existing customers were not in position to risk the investment necessary to construct private plants to serve their requirements; in other words, the competitive influence became temporarily noneffective. Of even greater importance is the fact that utility earnings were drastically reduced due to failing loads, and the industry was in no condition to meet theoretical competitive levels. Even so, temporary concessions were made by various companies in an attempt to induce some expansion in use and, in some instances, actually to prevent customers from closing down operations entirely. These temporary concessions cannot be evaluated in the type of index here presented.

With the firm trend of prices evidenced during the past several years, it is probable that rate levels for industrial power service will not be forced materially lower by competitive influences, except in individual cases where industrial rate structures may not have been previously reduced below the 1925 to 1928 level.

The volume of large commercial and industrial power that may be sold by any system is dependent not only upon the rate level of the system but also upon the degree of industrialization of the area served. This latter factor is usually controlled by the location of the territory with respect to markets and raw materials. With the exception of specialized processes, the cost of electric service is such a relatively small part of the total cost of manufacturing that industry does not generally follow low rates. Rather the reverse is the usual experience, so that it is found that extensively industrialized areas will generally have lower rate levels for large power loads, all other factors being equal, than will the less highly industrialized areas.

The competitive situation, with respect to the small commercial and residential customers, differs materially from that of the large commercial and industrial groups. With the small customer there is no question

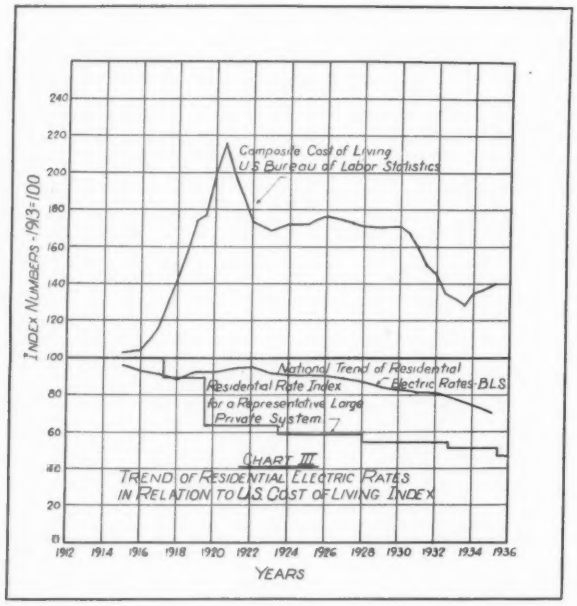

Composite Cost of Living
U.S. Bureau of Labor Statistics
National Trend of Residential
Residential Rate Index
for a Representative Large
Private System
Electric Rates: B.L.S.
INDEX NUMBERS - 1913=100
YEARS
1912 1914 1916 1918 1920 1922 1924 1926 1928 1930 1932 1934 1936

CHART III
TREND OF RESIDENTIAL ELECTRIC RATES IN RELATION TO U.S. COST OF LIVING INDEX

of competition between price levels set by privately owned sources of supply and the price of central station service; there is only one economical means of obtaining electrical service, and that is the central station system. Beyond certain minimum requirements, however, the development of sales in the small customer categories is definitely competitive. In this field the most potent competitive factor controlling the exploitable markets is that which arises from the cost and quality of identical services from other sources. Two obvious examples of this form of competition are gas cooking and water heating, as compared competitively with the electric range and water heater.

The competitive levels imposed by these other sources of service are frequently so low as to make impossible the development of large markets for electricity at prices that will not result in actual out-of-pocket losses. If relatively low gas rates are available, competitive dollar values for electrical cooking and water heating may be below production costs. Where this is true it is uneconomical, from the standpoint of the utility company and of the community as a whole, to attempt to develop sales in these categories, except to those customers in the higher income brackets who are willing to pay a higher price for certain advantages that they may consider to exist in the more expensive service.

Due to the inherent characteristics of utility costs, it is necessary to obtain large volume and extensive utilization of facilities, *i.e.*, high load factor, in order to make low rates economically feasible. Where competitive price barriers exist it is impossible to develop the sales volume necessary to support extremely low rates; hence reductions in rates, in the range of uses that are characteristic of these marginal services, can only result in decreased revenues with consequent impairment of economic position. No offsetting advantage to a major portion of the consuming public results from such reductions.

More subtle in its action is the competition that exists between other uses for the customer's income and the various semiluxury and luxury uses for electric service. For lack of a better term this may be called "budgetary competition"; thus a customer with a limited income must choose between an increase in his electrical utilization at a given rate level and a reduction in his expenditures for other commodities and services.

Because of this fact a wide reduction in rates for electric service, unless accompanied by extensive selling efforts, may result in nothing more than a realignment of the proportionate distribution of expenditures, with the resulting savings in costs, for a given quantity of electric service, being transferred to other categories of expense. However, with effective sales and market-development activities, it has been the general experience that reasonable revenue reductions can ultimately be recouped from increased sales. Nevertheless, revenue recuperation is a function of the breadth of the potential market as measured by the cost levels of competitive services and by the existing degree of sales saturation.

The process of reducing rates for residential service is necessarily slow, requiring, at each step, a proper evaluation of future sales possibilities, and of the effect of such sales upon system investment and operating costs. Particularly important is a proper evaluation of future sales possibilities, for if sales do not materialize, the financial position is permanently impaired. Furthermore, low prices do not in themselves guarantee proportionately higher use of service.

Trend of Residential Sales and Rates

An analysis of the history of the utility industry over the past 15 to 20 years indicates a continuous process of rate reductions accompanied by increases in the average use per customer in the residential category. These trends are shown graphically, on Chart II, in terms of average annual use per residential customer and average price per kilowatt hour sold. The increase in use per customer has been developed through the enlargement

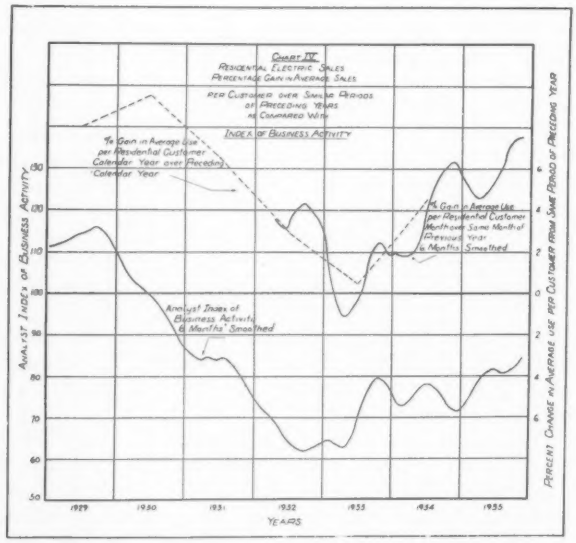


CHART IV
RESIDENTIAL ELECTRIC SALES
PERCENTAGE GAIN IN AVERAGE SALES
PER CUSTOMER OVER SIMILAR PERIODS
OF PRECEDING YEARS
AS COMPARED WITH
INDEX OF BUSINESS ACTIVITY
% Gain in Average Use per Residential Customer Calendar Year over Preceding Calendar Year
% Gain in Average Use per Residential Customer Month over Same Month of Previous Year 12 Months Smoothed
Annalyst Index of Business Activity 6 Months Smoothed
ANALYST INDEX OF BUSINESS ACTIVITY
PERCENT CHANGE IN AVERAGE USE PER CUSTOMER FROM SAME PERIOD OF PRECEDING YEAR
YEARS
1929 1930 1931 1932 1933 1934 1935

of markets resulting from the development of new appliances and processes. These markets, however, have been developed only through the expenditure of extensive selling effort.

Increased use has acted to lower rates progressively, as is indicated by the trend of average price paid per kilowatt hour, because with increased volume there has been made possible a thinner spread of fixed costs to each unit of energy. This reduction in average price has also resulted from the phenomenal increases in operating efficiencies achieved by the industry during the period under consideration.

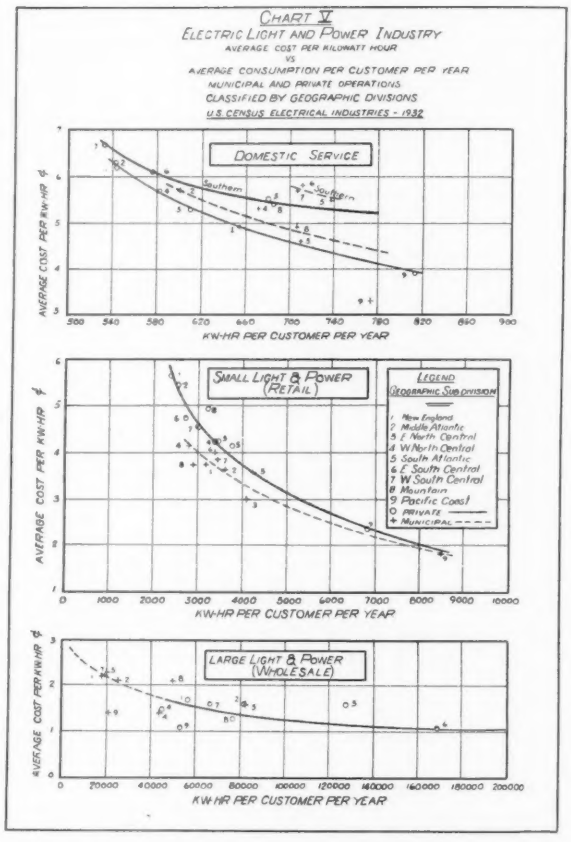
As indicated on Chart II the average sales per residential customer has increased more than twofold within the past 20 years; at the same time, the average price has been reduced to approximately three-fifths of its level at the beginning of the period.

Indicative of the differences in the economic characteristics of the residential and industrial rate structures is the fact that residential electric prices have shown little or no tendency to follow upward fluctuations in the general price structure. This condition is illustrated on Chart III, showing the United States Bureau of Labor Statistics' composite index of the "Cost of Living" and, from the same source, the index of residential electric costs. This latter index is based upon the costs of a fixed quantity of energy and as a result differs somewhat in relative values from the trend shown on Chart II. The latter indicates a somewhat greater reduction in costs due to the progressively larger quantities of energy that fell within the low price ranges of the various rate structures. To illustrate the general situation with a specific instance, there also is presented on Chart III the index of residential rate levels for one large metropolitan company. This history of almost continuous reductions in residential electric costs during a period in which other costs showed marked variations is a definite indication of the policies that have controlled the development of the electric utility business.

However, the trend of increasing average use of electric service has not been uninterrupted. Even in the field of domestic service the effect of economic conditions is felt; in other categories the direct incidence of economic conditions is even broader. Thus, small commercial sales declined in 1933 to 89.5% of the peak sales of 1930, and large industrial sales dropped in 1932 to 70.3% of 1929 peak levels.

The effect of economic conditions upon domestic service is graphically illustrated on Chart IV, which shows the trend of percentage gains in average use per customer over similar periods of the preceding years. In comparison with the trend of gains in average residential use, there is shown the combined index of business activity, as compiled by the *Annalist*. In order to eliminate extreme fluctuations in values, both curves are presented on the basis of six month average values, plotted to the last month of each successive six.

Although no annual loss in average sales was recorded, the percentage gains were cut from eight to ten per cent to less than one per cent. Increases in total sales declined to an even greater extent due to reductions in the total numbers of customers served. With a majority of industries recording heavy losses, it would seem that



gains, no matter how meager, are indicative of a particularly strong position. When it is realized, however, that capital investments, necessarily made in anticipation of actual needs, and reductions in rate levels are both made in expectation of a continuation of previously experienced patterns of load growth, it is apparent that a wide decline in the expected rate of growth is a serious matter.

That extensive rate reductions have been made during the years of depression is apparent from the index of rate levels shown on Chart III. This index declined 14.0% in the last five years.

As markets for electric service are further expanded, additional reductions in rate levels may be anticipated; but, unless operations are subsidized, it is financially impossible to make wide reductions very far in advance of increased sales. The two factors must be kept within reasonable balance of one another or an economically unsound condition results. On the other hand, if operations are subsidized, it is apparent that an over-all economic loss will be sustained by the community, due to sales expansion into markets where other forms of service are, in fact, more economical; furthermore, such procedure tends to expand markets into economic groups having little need for, or appreciation of, the marginal uses for the service.

Private and Municipal Plant Rate Levels

No discussion of electric utility rate levels or of the justification for govern- (*Continued on page 354*)

Five-Star Final on Alumni Day!

Technology's Homecoming Festival on June 8

FOURTEEN hundred and sixty-three Alumni already have indicated that they hope to attend the Alumni Day at the Institute on June 8 — a response that indicates the interest prevailing among Technology men and their families in this coming Festival, celebrating the Institute's 75th anniversary and the 20th anniversary of the removal to the present plant in Cambridge. Dedicated to pleasure and to an expression of Technology spirit befitting the two anniversaries to be marked, the Alumni Day program will provide opportunities for entertainment, renewal of friendships, and desirable educational experiences that will make June 8 an occasion memorable and delightful.

The program this year far surpasses last year's Alumni Day in interest and entertainment, and includes a number of innovations. Alumni will join with the senior class and their friends in the Class Day exercises of the afternoon, in the christening of Technology's new dinghy fleet, and in the dedication of the new sailing pavilion on the Charles. The feature of the morning will be the Conference on Transportation, designed to inform the layman about future trends in this field of universal interest. A luncheon in the Great Court for the Alumni, and a dinner and Pops concert in Symphony Hall are other items on the program which may be detailed at the present time as follows:

Program

9:00 A.M. AND ON. REGISTRATION and renewal of acquaintances in the main lobby of the Institute.

10:00 A.M. TRANSPORTATION CONFERENCE. The presiding officer will be the Hon. John Monroe Johnson, Assistant Secretary of Commerce, and the speakers, covering the four fields of transportation, include Edward P. Farley, President, American Hawaiian Steamship Company; Colonel Edgar S. Gorrell, '17, President, Air Transport Association of America; Edward W. James, chief, division of highway transport, United States Bureau of Public Roads; and Charles D. Young, Vice-president, Pennsylvania Railroad. These speakers will discuss the broad social implications of present-day trends in air, water, highway, and rail transportation.

1:00 P.M. LUNCHEON for all Alumni in the Great Court.

2:00 P.M. JOINT CLASS DAY EXERCISES with the senior class in the Great Court. The Class of 1911, holding its 25th reunion, is preparing a special stunt initiating the senior class into the alumni body, and thereafter the program, which will be in charge of the senior class, will include the christening of the Technology dinghies, the award of class gifts, the Beaver oration, and the welcoming by the Alumni Association of the senior class into the alumni ranks.

4:00 P.M. DEDICATION of the new sailing pavilion in front of Walker Memorial, a sailing regatta on the Basin, and a water carnival. At the conclusion of the program on the river, Alumni will have an opportunity to visit members of the Institute staff and the departments and laboratories in the Institute.

6:30 P.M. GRAND DINNER IN SYMPHONY HALL. The speakers will be the Hon. Joseph B. Eastman, Federal Coördinator of Transportation (he will also participate in the morning conference), President Compton, and Dr. George E. Vincent. The latter will talk on "The Unpopularity of Brains." The Hon. Newton D. Baker will be a guest of the Alumni at the dinner.

Following the program of speeches, there will be a concert by the Boston Symphony Pops orchestra. The dinner is for Alumni and Alumnae only. Seats in the balconies of Symphony Hall may be obtained for women guests, at $1.00 each, for the speaking and musical program following the dinner.

Program for the Ladies

A special effort is being made to provide for the wives of Technology Alumni an entertaining program throughout Alumni Day. There will be a bus trip to Concord and Lexington, beginning at 10:00 A.M. and arriving at 12 noon at the Wayside Inn at Sudbury for luncheon. Returning to the Institute by 3:00 P.M., the women may make a tour of inspection of the Institute with guides, watch the regatta on the Basin, and attend a tea to be given by Mrs. Compton and the Technology Matrons, probably in the Graduate House, at 4:00 P.M. At 5:00 P.M., busses will leave the Institute for the University Club where, at 6:45, dinner will be provided for the ladies. At 7:45, busses will take the women to Symphony Hall for the speeches and musical program.

Special Instructions

Other items on the program include the unveiling of a portrait of Dr. Harry W. Tyler, '84, and of a plaque commemorating the Rogers laboratory of physics. Special railway fares will be available on the identification certificate plan. Alumni are especially invited to the President's reception to graduates in Walker Memorial from 4:00 to 6:00 P.M. on the afternoon of June 9. *The price to alumni for the conference, lunch, and dinner on Alumni Day will be only $5.00.*

CLASS REUNIONS SUMMARIZED

The "five-year" classes whose reunion plans had crystallized in time for this issue of The Review are as follows:

1891 — 45th Reunion, East Bay Lodge, Osterville, Mass., June 19, 20, and 21.
1896 — 40th Reunion, East Bay Lodge, Osterville, Mass., June 4, 5, 6, and 7.
1901 — 35th Reunion, Oyster Harbors, Mass., June 6 and 7.
1906 — 30th Reunion, Oyster Harbors Club, Osterville, Mass., June 6 and 7.
1911 — 25th Reunion, Mayflower Hotel, Manomet Point, Plymouth, Mass., June 5, 6, and 7.
1916 — 20th Reunion, Place still to be determined, June 5, 6, and 7.
1921 — 15th Reunion, Norwich Inn, near Norwich, Connecticut, June 5, 6, and 7.
1926 — 10th Reunion, Toy Town Tavern, Winchendon, Mass., June 6 and 7, meeting for luncheon at Walker Memorial at 12:30 on Saturday, June 6.
1931 — 5th Reunion, Mayflower Hotel, Plymouth, Mass., June 6 and 7, meeting at 1:30 on Sat. June 6, at Crafts Hall, M.I.T. Graduate House.

Although they will not be celebrating five-year milestones, the following classes are among those which have scheduled more or less informal get-togethers:

1900 — 36th Reunion. Stag affair tentatively planned for week-end of June 5 on Cape Cod.
1905 — 31st Reunion, Boxwood Manor, Old Lyme, Connecticut, June 5, 6, and 7.
1915 — 21st Reunion. Plan to gather with families at hotel near Symphony Hall early on the evening of Alumni Day, June 8.
1917 — 19th Reunion. Possible get-together on Long Island.
1935 — 1st Reunion. Members of this class will gather in west lounge of Walker Memorial at 9 A.M. on Alumni Day, June 8.

JOIN THE TREK BACK TO TECH!

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Change in Entrance Requirements

THE entrance requirements of the Institute have been revised and the new regulations, which permit greater flexibility in the choice of subjects and require fewer examinations, will become effective next autumn. The changes affect particularly those students who cannot qualify under the plan which permits students in the highest fifth of their class to enter Technology without examination. For this group the number of specific examination subjects has been reduced, the field of elective subjects enlarged, and language requirements liberalized.

These new requirements are related to the Institute's plan for stabilization of enrollment, under which the number of students admitted to the first-year class will be limited to approximately 600, consisting of those students whose personal and scholastic records give evidence that they are capable of gaining the greatest value from a scientific or engineering education.

Under the new entrance regulations, high- and preparatory-school students will be able to follow a more general program of preparation for their later work in science or engineering. In addition to a thorough preparation in English, which is considered a subject of fundamental importance, it is also necessary to be prepared soundly in physics and mathematics, on which much of the first year's work at Technology is based. The electives which may be offered include languages; social, biological, or physical sciences; mathematics, mechanic arts, mechanical drawing, commercial studies, fine arts, drama, or music.

Director of Admissions

THE appointment of Professor B. Alden Thresher, '20, to be Director of Admissions of the Institute was announced on April 5 and is one of several administrative and faculty changes taking place in the fall. Professor Thresher will succeed Dr. James L. Tryon, who retires this year after serving 16 years as a member of Technology's academic administration.

The Institute's new Director of Admissions has been a member of the Faculty of the Department of Economics and Social Science to which he came as an instructor in 1929, and his particular interests have been the economic and social aspects of technology and invention. Professor Thresher was born in Dayton, Ohio, in 1896, and received his preparatory education at the Hotchkiss School, later coming to the Institute from which he was graduated in 1920. In 1927 he entered the graduate school of Harvard University, which granted him the degree of master of arts the following year.

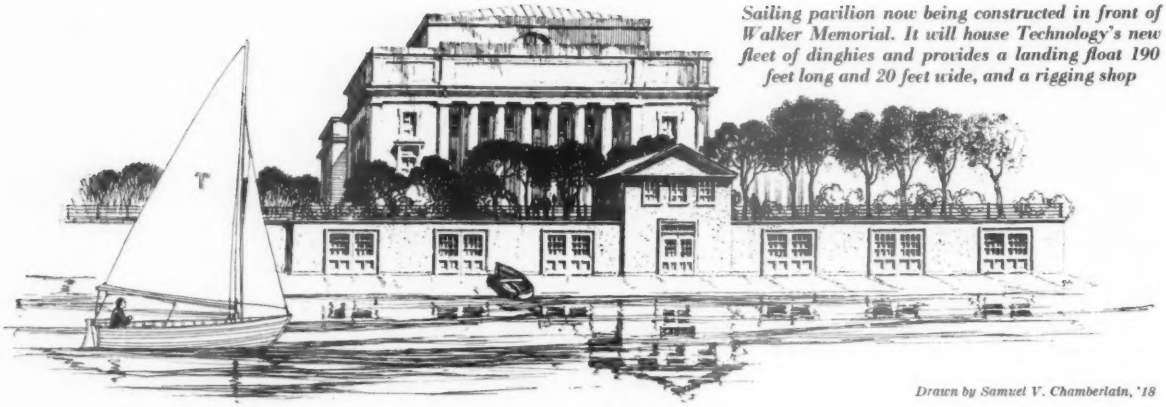
After serving as instructor at Technology for three years, Professor Thresher was appointed assistant professor, and last year was promoted to the rank of associate professor. He is the author of various articles and book reviews in technical and economic journals, and is co-author of "The Economic Process" and "The Organization and Management of a Business Enterprise."

Professor Thresher is a member of Sigma Chi, the American Economic Association, the Society for the Promotion of Engineering Education, and the American Association of University Professors. In addition to his educational work, he has had considerable business and industrial experience. From 1920 to 1925, he was assistant plant engineer of the Eddystone Manufacturing Company, leaving that position to join the staff of the research division of the Dennison Manufacturing Company.

Dr. Tryon, the retiring Director of Admissions, is known to thousands of Technology students as a patient and understanding friend, as well as a kindly counselor advising them on entrance requirements and the choice of their professional courses. As a lecturer on vocational education, he has visited most of the colleges and preparatory schools of this country and Canada and is widely known among college officials. He has taken a particular interest in the welfare of foreign students at Technology and has been active in many ways to help

Purdy

James L. Tryon, Director of Admissions, who retires this year. The Review speaks for thousands of Alumni who know Dr. Tryon in congratulating him on his 16 years of distinguished service to Technology and in expressing good wishes to his successor, Professor Thresher



Sailing pavilion now being constructed in front of Walker Memorial. It will house Technology's new fleet of dinghies and provides a landing float 190 feet long and 20 feet wide, and a rigging shop

Drawn by Samuel V. Chamberlain, '18

them adjust themselves to the American manner of living and the requirements of the American educational system.

Dr. Tryon, who retires with the title of Honorary Lecturer, joined the staff of the Institute in 1920, when he was appointed assistant registrar with the rank of assistant professor. He also served as assistant to the secretary of the Faculty in 1926–1927, and was appointed Director of Admissions in 1930. His promotion to the rank of professor and lecturer in vocational education came in 1930. He was graduated from Harvard University in 1894, and three years later received the degree of bachelor of divinity from the Episcopal Theological School. Later he studied law at Boston University, receiving his degree in that field in 1909, and his doctorate of philosophy the following year. He is widely known as an authority on international law, in which he has given courses at Maine and M.I.T.

Dr. Tryon is a member of the Appalachian Mountain Club and has twice been president of the Field and Forest Club of Boston.

Appointment

ALSO announced in April was the appointment of John M. Lessells, prominent consulting mechanical engineer, of Swarthmore, Pa., as Associate Professor in the Department of Mechanical Engineering at the Institute. He will be occupied with teaching and research in the field of engineering materials.

Mr. Lessells was born in Scotland and served a five-year engineering apprenticeship before being graduated from the University of Glasgow. During the War he was employed on inspection of engine parts and materials for Rolls-Royce, Armstrongs, and the British War Office. After the War, he joined the research staff of the Westinghouse Electric and Manufacturing Company at Pittsburgh, serving as manager of the applied mechanics division for eleven years. He later became engineering manager of the turbine and Diesel department of Westinghouse at Philadelphia, a position from which he resigned recently to enter practice as consulting engineer to Westinghouse and others. In partnership with Professor G. B. Karelitz he has been identified with some of the mechanical details of the 200-inch telescope to be erected on Mount Palomar, California.

Mr. Lessells is editor of the *Journal of Applied Mechanics* published by the American Society of Mechanical Engineers. Besides his activity as a member of this society, he is a member of the Iron and Steel Institute, the American Society for Testing Materials, and the Institution of Mechanical Engineers of Great Britain. The latter, in 1926, awarded him the Bernard Hall prize for a paper on fatigue and elastic limit.

At Technology, Mr. Lessells will offer courses in the materials of engineering, to which he brings a wide background of experience on both sides of the Atlantic.

Promotions and Retirements

PROMOTION of 18 members of the instructing staff to the rank of associate or assistant professor, and the retirement of five well-known members of the Faculty who have long been associated with the Institute, were among other important announcements made at Technology early in April.

Members of the Faculty who will retire this year are: Professor James R. Jack, Head of the Department of Naval Architecture; Professor George B. Haven, '94, Professor of Advanced Machine Design and in charge of textile research in the Department of Mechanical Engineering; Professor Leonard M. Passano and Professor Nathan R. George, both of the Department of Mathematics; Professor Carroll W. Doten, Professor of Political Economy. All will retire with the title of Professor Emeritus.

Staff members promoted to the rank of associate professor are: Jayson C. Balsbaugh, '24, Ernst A. Guillemin, '24, and Harold L. Hazen, '24, all of the Department of Electrical Engineering; Roy W. Carlson, Civil and Sanitary Engineering; Louis Harris, '20, of the Department of Chemistry.

Promotions to assistant professor were: Wilmer L. Barrow, '29, and John G. Trump, '33, of Electrical Engineering; Albert A. Lawrence, Theodore Smith, and, Robert S. Woodbury, '28, of the Department of English and History; Edward M. Bridge, '13, and J. Talmage Woodruff, '17, of the Department of Architecture; Alexander J. Bone, '24, of the Department of Civil and Sanitary Engineering; Samuel C. Collins, Department of Chemistry; Edwin R. Gilliland, '33, Department of Chemical Engineering; Prescott D. Crout, '29, Depart-

ment of Mathematics; Alvin Sloane, Department of Mechanical Engineering; Edward S. Lamar, Department of Physics.

Professor Jack, retiring Head of the Department of Naval Architecture, joined the staff of the Institute in 1919, when he gave a series of lectures on naval architecture. The following year he was asked to take charge of the department, and in 1923 he assumed the additional duties of Dean of Navy Students. He is a native of Scotland and studied at the University of Glasgow before entering the great shipbuilding firm of William Denny and Brothers, Ltd., at Dumbarton, where during a long and distinguished career he designed more than 350 ships of various types. Upon retirement Professor Jack will become an Honorary Lecturer in the department of which he has been in charge for 16 years.

Professor Haven, who was born in Sangerfield, New York, is a graduate of the Institute with the Class of 1894, and joined the teaching staff in 1896. He is widely known as an authority on machine design and textile machinery as well as methods of research. His contributions to technical literature include several books and many articles. He is a member of the United States Institute for Textile Research, Inc., and for his contributions in the field of textile research he was awarded a medal by the National Association of Cotton Manufacturers in 1931.

Professor Passano, a member of the Department of Mathematics since 1892, was born in Baltimore, Md. From 1886 until 1892, he attended Johns Hopkins University, where he majored in economics, mathematics, and English literature. In addition to his teaching, he has contributed widely to both professional and literary publications.

Professor George is a native of Mendon, Mass., and was graduated from Harvard University in 1890. He joined the Institute's Department of Mathematics 45 years ago and has been Professor of Mathematics since 1913.

A native of Panton, Vt., and a graduate and former secretary and registrar of the University of Vermont, Professor Doten joined the staff of Technology 33 years ago. After his graduation from the University of Vermont in 1895, he continued his studies at Harvard University, being graduated in 1902. He retires as Professor Emeritus of Political Economy.

Professor John C. Slater, Head of the Department of Physics, has been granted leave of absence for the second term of the next academic year, while Professor Nathaniel H. Frank, '23, also of the Department of Physics, will be on leave of absence during the first term.

Physics for Industry

A NEW group of courses in applied physics designed to meet the growing demand for scientists with special training for the application of physics in the solution of industrial problems was announced recently by Professor John C. Slater, Head of the Department of Physics. Professor George R. Harrison, Director of the Research Laboratory of Experimental Physics, has been appointed Director of Applied Physics and will be in charge of the courses, which will begin next autumn.

President Compton, who as chairman of the national Science Advisory Board studied the possibilities of applying the knowledge and discoveries of science in industry, is also chairman of the American Institute of Physics, which after a study of several years has suggested the type of training which will be most valuable for physicists who expect to enter the research, development, or engineering branches of industrial organizations. In this study the requirements of a large number of industries were considered, with the result that a permanent national council on applied physics was established. While physics has already played an important part in recent advances in many fields, it is destined to have a still more significant rôle in the future.

Training in applied physics is expected to be especially valuable in the electrical, optical, chemical, textile, paper, printing ink, aircraft, and automobile industries, as well as in oil production and refining, geology and geophysics, acoustics and metallurgy.

Physical principles, for example, will enter into the development of economical railway trains, prefabricated houses, air conditioning, the preservation of food, the processing of plastics, which include glass, rubber, paint and composition moulding materials, color photography, television, and many others.

Students in the new courses will devote more time to chemistry, metallurgy, and the fundamentals of electrical and mechanical engineering. The new program supplements rather than competes with the long-established course in pure physics, which goes farther into the speculative aspects of science. Thus there will be no sharp distinction of staff, subjects, or students between the two fields of study, for under the new plan students will be able to follow their inclinations and aptitudes in one direction or the other through proper selection of their elective courses.

The facilities of the courses will include the Eastman Laboratories of Physics and Chemistry and the Institute's Spectroscopy Laboratory.

Courtesy Boston Post

Walter C. Wood, '17, and President Compton sailing one of the new Technology dinghies in the Charles River Basin. Mr. Wood has been appointed sailing master of the student's Nautical Association

Abroad

PROFESSOR Walter G. Whitman, '17, Head of the Department of Chemical Engineering, will be the official representative of the Institute at the centenary celebration of the founding of the University of London, which will be held in London, June 28 to July 3.

While in England, Professor Whitman will also attend the joint meetings of the American Institute of Chemical Engineers and the British Institution of Chemical Engineers, as well as the Chemical Engineering Congress of the World Power Conference, which meets in London from June 22 to June 27. Among the papers to be presented to the Congress will be one on "Heat Transmission," of which T. B. Drew, '23, and Professors H. C. Hottel, '24, and W. H. McAdams, '17, of the Department of Chemical Engineering are the authors.

Changes in Curriculums

REVISION of the Institute's curriculums, including simplification of courses and improvement in methods of presentation in the Departments of Science and Engineering, has been announced by Professor Charles E. Fuller, '92, Chairman of the Faculty. The changes, which become effective next autumn, were adopted after an exhaustive study of several years by faculty members. The new plan provides for unification of subject matter and closer contact between members of the Faculty and students.

Under the revision the Faculty has adhered to the plan, inaugurated by the Institute in its early days, to offer its students a wide choice of courses in the various branches of pure and applied science and engineering. It is considered important that students have the opportunity to choose a course that stimulates their interests and provides an incentive for active and vigorous effort. Under a purely elective system, however, very few undergraduates have sufficient background or experience to enable them to choose a curriculum in any given field with a proper sequence and coördination of studies. This problem has been met by arranging courses in a comparatively large number of fields and, in several of these, providing further differentiation by allowing a choice of several options.

The arrangement of the revised curriculums is such that, except in the Department of Architecture, the course of studies for the first year, which includes mathematics, physics, English, and history, is the same for all students. With this exception, a student is not therefore required to elect his professional course until the end of the freshman year.

The curriculums for the sophomore year for all departments carries forward the same fundamental courses undertaken in the first year, but they are differentiated by the inclusion of one or two introductory professional studies to broaden the groundwork for the courses that follow in the upper years. The greatest difference is between the curriculums in the departments which require an extension of the fundamental course in chemistry throughout the sophomore year and the departments in which little if any chemistry is required beyond the freshman year.

Within either of the foregoing groups the differences in the second year curriculums are relatively small. If a student feels at the end of the freshman year that he did not make the most satisfactory choice of a course, he may, at the end of the sophomore year, change from one course to another within his elected group. This change may be accomplished by taking during the summer between the sophomore and junior years the introductory work he has missed. Thus the choice of the course elected by a student is not necessarily final until the end of the sophomore year.

Sunlight and shadows in the main lobby of the Institute

In the junior and senior years stress has again been laid on fundamentals. The objective in the selection of studies in the curriculum of each branch of engineering and science is to provide a thorough training in basic principles with a limited specialization in any field.

In meeting this objective the branches of study to be undertaken at any one time have been limited to a number small enough to enable him to devote the time required to acquire a thorough training in each branch and to avoid the superficiality which results from too wide a spread of effort.

Under the revision students will devote more time to study and less to formal class work, a change which is expected to encourage thoughtful consideration of problems under conditions which in some degree approximate those encountered in professional work. More time has been allotted to conferences between students and members of the teaching staff, for the personal contacts established by consideration and discussion of current matters in engineering and scientific research are considered a very valuable factor in a student's education. It is hoped that greater individual responsibility and closer relationships with the Faculty will materially help students to meet the problems of adjustment that often occur in the transition from college to professional work.

A definite portion of the curriculum for each department has been allocated to nonprofessional studies, partially elective, in the fields of English and history, economics and social science, philosophy, literature, language, and the fine arts. The object of this is to broaden the student's education beyond the limits of the professional field he elects, give him a better preparation for properly meeting his obligations in whatever business and social environment he may be placed.

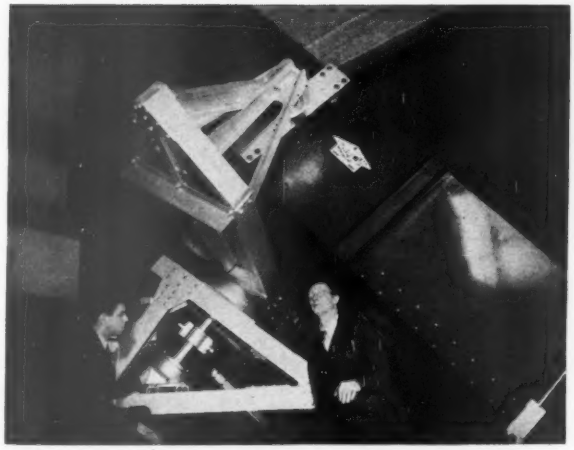
Studies in the freshman and sophomore years include basic courses in military science. In the junior and senior years advanced R.O.T.C. optional courses are offered to students who are citizens of the United States.

Throughout the Institute the aim is to develop good mental habits and correct methods of study, broad mental power, good judgment, and the initiative and ability to work out on individual responsibility the solution of the problems which the student may meet in the practice of his profession.

Medals

TWO members of the Institute's Faculty, Dr. Waldemar Lindgren, Professor Emeritus of Geology and former Head of that Department, and Dr. Alfred V. deForest, '11, Associate Professor of Mechanical Engineering, have recently been awarded medals in recognition of their achievements in the field of science.

Dr. Lindgren has received the *Médaille Gustave Trasenster* given by the association of alumni engineers of the Université de Liége, Belgium, which has previously honored only four other scientists in this manner. In announcing the award to Dr. Lindgren the *Revue Universalle des Mines*, an alumni publication of the Université, pointed out that their aim this year was to honor a man particularly distinguished in economic geography, which has been Dr. Lindgren's chosen field. The medal was officially accepted by Hon. Dave H. Morris, American Ambassador to Belgium, for Dr. Lindgren, and has been transmitted to him through diplomatic channels.



This giant camera, one of the largest spectrographs ever built, is to be used by the Harvard-M.I.T. eclipse expedition to observe the total solar eclipse in Russia on June 19. Made of Dowmetal, the spectrograph box, which is 12 feet long, three feet wide, and five feet deep, with its mountings weighs less than half a ton.

Inside the spectrograph will be housed four plane gratings, polished metal surfaces ruled with 15,000 lines to the inch, which will be used, each with a lens and camera, to photograph the crescent of the eclipsed sun and the corona in lights of different wavelengths, ranging all the way from ultraviolet to the infra-red.

Built by the Dow Chemical Company, the big spectroscope has just been set up for final testing at the Institute before shipping to Russia. Left to right. *Henry Hemmendinger and Dr. Donald H. Menzel, director of the expedition, both of Harvard Observatory*

Dr. deForest has been awarded and will receive, this month, the Edward Longstreth Medal of the Franklin Institute, for his achievements in metallurgical research. Recommendation for the honor is made by the Institute's committee on Science and the Arts and it goes to Dr. deForest for his work on the accurate testing of finished products without injury to them. The medal is awarded annually for "inventions or for meritorious improvements in machines and mechanical processes."

Albert Farwell Bemis, '93 (1870–1936)

THE Review records with sorrow the death of Albert Farwell Bemis, '93, on April 11 as a result of complications arising from an apparently not serious fall he suffered while taking pictures of the Grand Canyon, the preceding Saturday.

Mr. Bemis was one of Technology's most loyal and distinguished Alumni. A Life Member of the Corporation, he served on many committees in various capacities relating to nearly all phases of Institute life. Only last June he became one of the 24 founder members of the Research Associates of M.I.T., a group of leaders and organizers of American industry who contribute to the support of research at the Institute. He was elected President of the Alumni Association in 1910 and during his term of office was responsible for many beneficial changes in the Association including the system of election by Alumni of Term Members to the Institute

Garo

Albert Farwell Bemis, '93, Life Member of the Corporation, generous friend of the Institute, who died on April 11 as the result of an accidental fall at Grand Canyon (see below)

Corporation. At various times he has been a member of Visiting Committees to a number of Institute departments, notably Civil Engineering, Architecture, Naval Architecture, and the Division of Industrial Coöperation. He played an important part in the development of Technology's dormitory system and contributed substantially toward the cost of the Class of 1893 dormitory. He was always interested in Technology's younger men and was responsible for placing many graduates in positions from which they later rose to prominence. His influence and help at Technology will be sorely missed.

The major portion of his business career was spent with Bemis Bro. Bag Company of which he was president from 1909 to 1925 and chairman from 1925 until his retirement from this activity in 1934; he was a founder of the Angus Company, Ltd., operating a jute mill and jute machinery works in India, a country in which he was always greatly interested; he had been a director of several other textile companies, notably Boott Mills of Lowell, Mass., from 1905 to 1924; also a director of the Second National Bank of Boston from 1916 to 1926 and of the Federal Reserve Bank of Boston from 1928 to 1932. Other business interests, coupled with a life-long interest in research and economics, made him a member of the Executive Committee of the National Industrial Conference Board from 1928 to 1932 and again from 1934 until his death, during which he was also chairman of the Advisory Council on Research.

Mr. Bemis always maintained a lively interest, almost a dominating interest, in architecture and building. In addition to the Technology dormitory construction, he made possible, almost single-handed, the rebuilding of the great tower of Lincoln Cathedral, England, both by his large financial contributions and by his close coöperation with Lincoln's great rebuilder, Dean Fry; with the Duke and Duchess of York he was a guest of honor at the rededication and thanksgiving services in Lincoln in 1932. This interest in building made him the founder of the Housing Company in 1918, an institution which built many of the finest group housing developments in New England and elsewhere, notably those at Bridgeport and Nashua; he was an active and constant supporter of housing research, both economic and physical, with a view to the production of better housing for the lower-income groups; in the field of housing he became a nationally known authority. The latest results of this work are a three-volume book, published by The Technology Press, under the general title of "The Evolving House," the last volume of which he had completed just prior to his death.

In addition to these major interests, Mr. Bemis retained to the end a deep concern in all sorts of human activities: He was an eager traveler and had visited most of the nations of the world; he did his utmost to promote better Anglo-American relations and held a life governorship in the English Speaking Union of London and was a life member of the Royal Society of Arts, also of London; nearly as many friends will mourn his death in England as in his own land. The Orient interested him, too, particularly India and the oriental side of Russia, and he wrote many papers about these lands. In India his company did much to improve the conditions of the natives, notably from the point of view of health and sanitation. Study of economics led him also to write many forceful papers for such organizations as the American Academy of Political and Social Science.

Technology Alumni and the Technology community will long remember not only Mr. Bemis' manifold and successful career in widely varying fields and his unstinted generosity in many directions, but more importantly his kindliness, his humanity and sympathy, and his love for and help to the young.

Coördinator

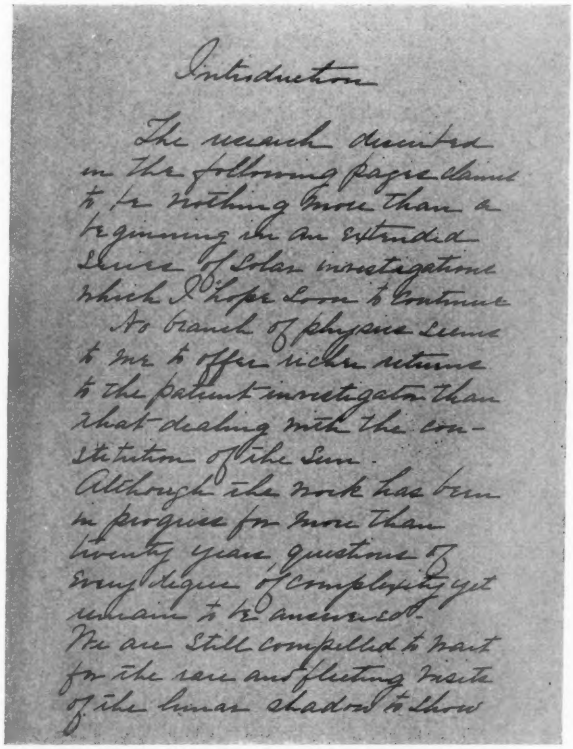
PROFESSOR J. W. M. Bunker has been appointed Director of the Research Laboratories of Biology, a field in which he has long been active in the Department of Biology and Public Health. The research program now going forward under Dr. Bunker's supervision includes his own work and that of Dr. Robert S. Harris, '28, in the field of experimental rickets, as well as investigation by Dr. Murray P. Horwood, '16, of the sanitary significance of certain bacteria in water, milk, and other foods, studies of the microbiology of the upper air by Dr. Bernard E. Proctor, '23 and the growth of bacteria by Dr. Marshall W. Jennison, '27. Dr. J. W. Williams is investigating the control of fungus diseases in man, while Dr. Cecil G. Dunn, '30, is making an evaluation of chemical compounds as germicidal and fungicidal agents. Dr. Bryce Prindle, '31, a Research Fellow, is investigating the biochemical effects of bacteria and molds on wool and cotton in relation to damage and fiber structure.

Council Meetings

ON the date that this issue of The Review is scheduled to go into the mails the Alumni Council holds an open meeting at which the speaker will be James B. Conant, President of Harvard University, and the guests the presidents of Boston College, Boston University, Northeastern, Simmons, and Tufts.

At the preceding, or 186th meeting of the Council, on March 30, 81 members and guests gathered in Walker Memorial to transact business and to hear Dean A. Fales, '14, Associate Professor in the Department of Mechanical Engineering, speak on "Can Safe Automobiles Be Built?" The gist of Professor Fales' talk appeared as a formal article in the April issue of The Review (page 276).

The Secretary at this meeting reported that alumni dues collections totaled 6,099, which is 295, or five per cent, more than the final total a year ago and 544, or ten per cent, more than the final total two years ago.



Introduction

The research described in the following pages claims to be nothing more than a beginning in an extended course of solar investigations which I hope soon to continue. No branch of physics seems to me to offer richer returns to the patient investigator than that dealing with the constitution of the Sun. Although the work has been in progress for more than twenty years questions of every degree of complexity yet remain to be answered. We are still compelled to wait for the rare and fleeting visits of the lunar shadow to show

On April 7 scientists met at Harvard to honor George Ellery Hale, '90, director emeritus and originator of Mount Wilson Observatory, inventor of the spectroheliograph, founder of the California Institute of Technology, one of America's greatest astronomers.

Above is a facsimile of the introductory page to Dr. Hale's thesis submitted to the Institute's Faculty in 1890 in accordance with the requirements for the degree of Bachelor of Science in physics. Included in this thesis was his original design of the spectroheliograph.

At the symposium in recognition of Dr. Hale's great contribution to science, Harry M. Goodwin, '90, Dean of Technology's Graduate School and classmate of Dr. Hale spoke, as did Robert B. King of the Physics Department

Robert F. Elder, Associate Professor of Marketing, and Louis F. Woodruff, '18, Associate Professor of Electrical Engineering, with the instrument, developed by the latter, for automatically recording the preferences of radio audiences. The device, attached to a radio, shows the hour when a radio is turned on or off, the station tuned in, and any change made in stations

The President spoke of the death of Frank A. Bourne, '96, council representative for Chile, which occurred on February 15, and it was announced that the Executive Committee had elected John E. Burchard, 2d, '23, as his successor. Gilbert M. Roddy, '31, had been elected class representative on the Council and Edward L. Moreland, '07, council representative for the new Knoxville club. Since the constitution of the Association prohibits the recognition of a local club within the 25-mile radius of Boston, the Executive Committee had decided that such clubs as might be organized within that radius could be designated as associate clubs without any council representation except that they would be privileged to send one of their number as a guest member to the Council without the privilege of voting.

The Alumni Council unanimously passed the following vote: "that it concurred in the action of the Executive Committee to the Institute Corporation in allocating the William Barton Rogers fund to scholarships rather than to student loans, the particular place in the Institute's scholarship funds to be determined by the President and Treasurer of the Institute, as well as the terms covering scholarship grants from the fund."

Changes in Naval Architecture

PROFESSOR Henry H. W. Keith, '05, long a member of the Institute's Faculty, has been appointed acting head of the Department of Naval Architecture and Marine Engineering. He will take over the duties of Professor James R. Jack, whose retirement is announced elsewhere. In the autumn the department will welcome to its staff Frank M. Lewis, of the faculty of the Webb Institute of Naval Architecture, whose appointment to Technology has just been announced.

Professor Keith after graduation carried on important research work in the United States experimental model basin at the Navy Yard in Washington. He joined the staff of M.I.T. in 1910, continuing his academic work until 1917 when he enrolled in the United States Naval Reserve and was attached to the Boston Navy Yard as

materials officer, naval architect, and design superintendent with the rank of lieutenant commander. Detached from active duty in 1920, Professor Keith returned to his work at the Institute and in 1928 was promoted to the rank of professor of naval architecture. He is widely known as a consulting engineer, and as an authority on the launching of ships. In this field he has been associated with the launching of most of the large vessels at the Fore River plant of the Bethlehem Shipbuilding Corporation in recent years. He is a member of the Society of Naval Architects and Marine Engineers, and the Society of Naval Engineers.

Professor Lewis is well known among naval engineers as an authority on problems of vibration in ships and marine power plants, a field in which he has carried on important investigations. He graduated from the Webb Institute in 1917.

THE STORY BEHIND YOUR LIGHT BILL

(*Continued from page 345*)

mental operation is complete without reference to the relative cost levels that have heretofore existed under private and municipal operation. In general it may be stated that the same basic factors control costs regardless of the form of the operating control. However, efficiency of operation will have very marked effects upon the magnitude of cost components entering into the various price structures. A thorough analysis of the most recently available statistics indicates higher over-all costs, all factors considered, to the customers of the 1,800 to 1,900 municipal electric systems than would have been paid had these municipal systems been consolidated with the privately operated systems.

In the comparison presented in the following paragraphs consideration has been given to all relevant factors, such as differences in utilization characteristics, known peculiarities in reporting sales and revenues, and to the very important factor of the tax differentials existing between private and municipal operations.

The most recently available data separately covering municipal and private operations are those compiled by the United States Census Bureau, in the Census of Electrical Industries for the year 1932. Unfortunately this census is not taken annually, thus the data presented is approximately three years old. Relatively, however, there will have been little change during the past several years.

Comparisons of group average prices are worthless unless accompanied by explanatory data to make possible adjustments for the several variables that control average rate levels. Thus, the "raw" statistics developed by the census indicated a combined average price of 2.7 cents per kilowatt hour for all energy sold by privately operated electric systems; the average for municipal systems was 3.1 cents per kilowatt hour. Such comparisons are valueless when it is realized that approximately 50% of all private utility sales were to customers of the industrial power group at an average price of 1.5 cents per kilowatt hour; the municipal systems had less than 15% of their sales in this particular classification. If total sales for the year 1932 are allocated to the major customer classifications the following comparative values will be found:

	Domestic		Small Lt. & Pwr.		Large Lt. & Pwr.	
	Kwh. per Customer	*Cents per Kwh.*	*Kwh. per Customer*	*Cents per Kwh.*	*Kwh. per Customer*	*Cents per Kwh.*
Private Systems....	600	5.6	3,288	4.3	87,474	1.5
Municipal Systems..	708	4.7	5,199	2.6	31,249	1.7
Total.....	611	5.5	3,418	4.1	85,345	1.5

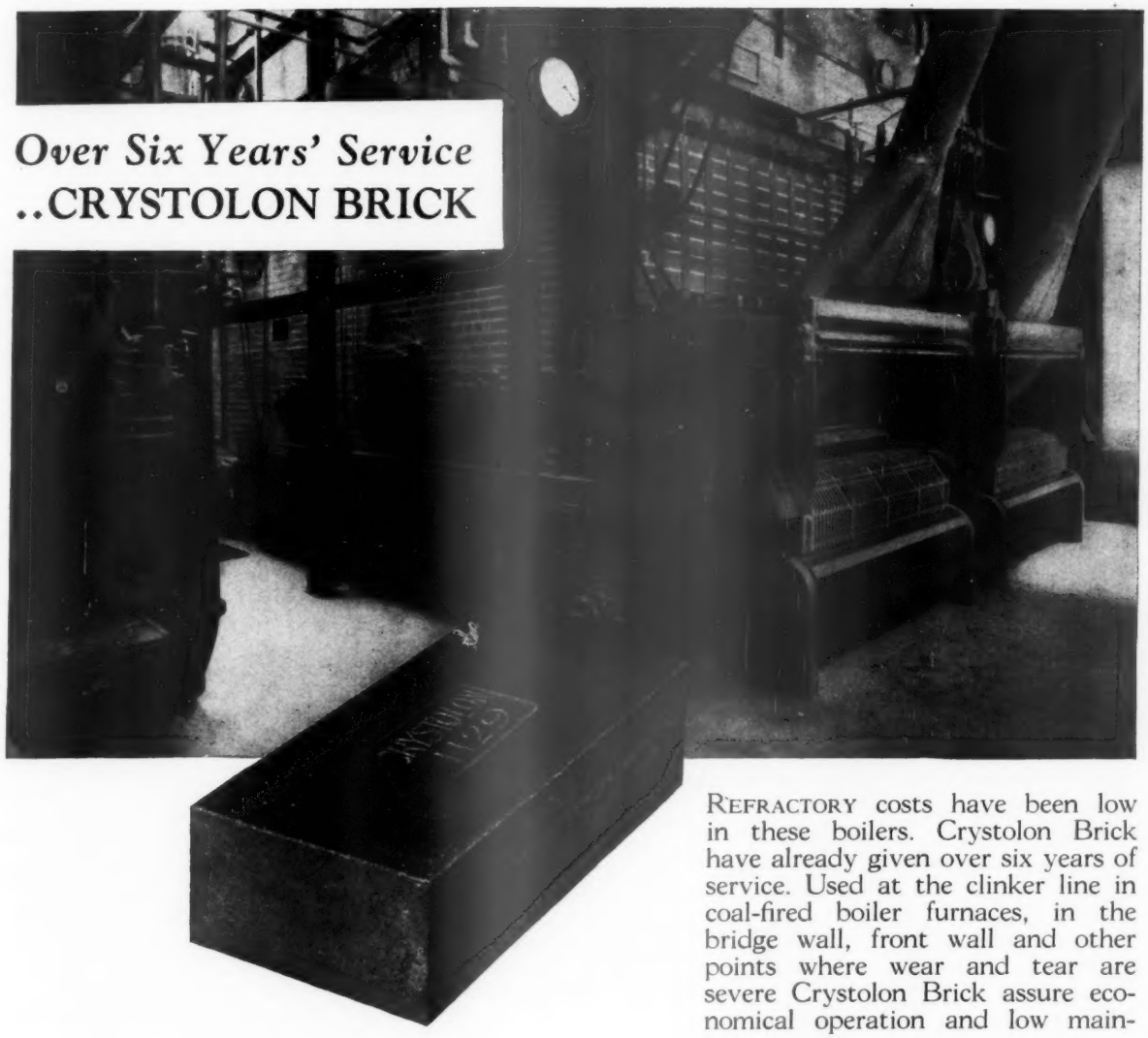
If no consideration is given to modifying factors, these values would indicate a considerable differential in favor of municipal rate levels for both the domestic and the small commercial classifications. Such a comparison is, however, unsound because it fails to take cognizance of the important variable of average use per customer and its effect upon average rate level. Due to the characteristics of the generally accepted rate forms, it is inherent that relatively lower average prices accompany higher average utilization values. This factor accounts for major portions of the differentials disclosed above.

Using the fact that variations in average use are accompanied by proportionate variations in average price it is possible to prepare the family of curves presented on Chart V. These curves show the relationships existing between average annual use and average price for both private and municipal operations. Values for each of the nine geographic divisions were used as a basis.

A comparison of the rate levels indicates generally lower domestic rates on the private systems than on the municipal systems; the opposite relationship exists in the small commercial category. The average differential in this latter group is, however, approximately equivalent to the average tax differential existing between the two methods of operation. In the large light and power category, the relative levels are difficult to determine due to the wide dispersion of individual values. For this analysis, the two trend lines may be considered to coincide. From the graphical relationships here developed it is possible to obtain the average and approximate total revenue differentials between municipal and private operations under any specific condition of consumption.

However, before a true comparison can be made, it is necessary to give consideration to the fact that municipal utility operations are tax exempt. During the year under consideration (1932) the over-all tax burden of the electric utility industry was $217,000,000, or approximately 11.8% of total revenues. Taxes paid by municipal operations were between one and two per cent of total revenues, leaving a differential of about 10%.

A municipality, when considering the adoption of municipal operation, fails to consider the possible repercussions of the tax-exemption privileges. While, in the individual case, the loss of tax revenue may be insignificant the combined effect of a number of such situations ultimately results in an inequitable shift of tax burdens to the citizens of other municipalities, to say nothing of possible increases in the tax bill (*Continued on page 364*)



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SCIENCE AND THE FINE ARTS

(*Continued from page 341*)

author of several modern novels which have attracted wide attention. Alfred Parker Morell, IV-A, '28, is the author of "Diamond Jim Brady" which was listed among the best sellers in biography in 1935.

These contributions of our Alumni to the fine arts are samples. It would be impossible to include all Alumni with an artistic temperament in the limited space of this article. The case as stated should be sufficient to prove that technical education does not suppress esthetic values. There is no reason to assume that in the future, as well as in the past, our graduates will not continue to create things of beauty whether they have a useful purpose or not.

We may now consider to what degree workers in science have coöperated in the development of the fine arts. The architect without question leans heavily upon the engineer. An architectural vision which cannot be raised into the air and stand firm must remain a picture of what might have been if scientists had been willing to help. The engineer has introduced tension to the structure; otherwise Broadway might have been crisscrossed with flying buttresses. Scientific research has developed new structural materials, new methods of fabrication, and more rapid and cheaper methods of construction. The skyscraper without the electric elevator would never have been built.

Most of the statuary and ornamentation of stone and wood is now carved by machinery in reproduction of a model and the casting of statuary in plaster or metal is an exacting technical process. The synthesis of new plastics, such as that obtained from carbolic acid and formaldehyde, has given the sculptor a new medium with which to mold the smaller statues and bas-reliefs. The Institute offers a course in ceramics which is dedicated in part to the scientific composition and construction of ornamental objects.

The excellence and permanence of a painting depends inherently upon the quality of the pigments and the foundation material. The soluble media used by the old masters often consisted of eggs, milk, honey, fish glue, or wine. During one early period of painting, all portraits were made with red lead, with obvious monotony. The Latin word for red lead is (*Continued on page 358*)

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SCIENCE AND THE FINE ARTS

(*Continued from page 356*)

minium and is the etymological origin of the present day miniature. In other words it had originally nothing to do with its minute size. Modern chemistry has given the painter standardized and more durable oils and varnishes.

Another direct influence of science upon painting is indicated by the increasing use of mathematical principles in the composition and design of a picture. The use of the principles of perspective is well known. In the middle of the Nineteenth Century Zeising, and later Fechner, developed the principle of the "golden section ratio." The theory has recently been given further impetus by the work of Churchill and Conrow. Art literature of today, in consequence, contains frequent reference to such terms as "mathematical analysis," "biometric pattern," and "pentagonal symmetry." The meaning of the golden section ratio may be explained by taking as an example the simple figure known as the cross, the symbol of the Christian religion. Where should the horizontal line intersect the vertical line to make the most pleasing cross? According to the golden section ratio it should intersect the vertical line at a distance from the bottom equal to 21/34ths of its height. Incidentally, a calling card having rectangular dimensions of the same proportion will be selected by most people as the best and the most pleasing in form. The ratio with its integral multiples in either numerator or denominator may also be shown to apply to the proportions of the perfect human figure.

At the turn of the century the prescription of most schools of art was: "Paint what you see." The camera sees so much better and, with the aid of distorting lenses and color filters, has produced such pleasing effects as to change the prescription of the painter of modern art to: "Don't paint what you see." Something had to be done by the painter to protect his calling and he may still be somewhat apprehensive as to the future. It is not improbable that we shall some day have a machine which will paint with brushes and pigments a picture of any object or scene within the range of its lens. If a "genuine" oil painting is desired, distorting lenses can produce any desired effect so that it can still be said that "a portrait is a picture of a man with something wrong with the mouth."

The introduction of action in the motion picture is another important contribution of science to the delineation of human interests. (*Continued on page 360*)

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Facsimile of front page of The Davenport Democrat

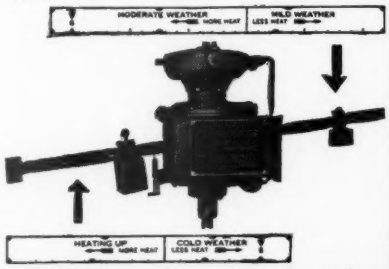
IOWA NEWSPAPER CUTS HEATING COSTS $517

Davenport Democrat Uses Webster Hylo System to Improve Heat Distribution, Lower Cost

Davenport, Ia.—The Democrat Building, home of the Democrat Publishing Company, publishers of the Davenport Democrat for more than 80 years, reduced the cost of heating during 1934-35 a total of $517, as the result of a Webster Heating Modernization Program which converted the installation into a Webster Hylo System of Steam Heating.

The modernization included necessary changes in piping to fit the installation to newspaper requirements, installation of radiator traps and accurately sized metering orifices in each of the 74 radiators and application of a central Webster Hylo Steam Variator Control.

The saving of $517 represents a 27 per cent reduction in cash expenditure for heating. At this rate, modernization will repay its entire cost in less than three years.



Webster Hylo Steam Variator—a simple, rugged central control for use with Webster Systems where distribution of steam to all radiators is balanced by accurately sized metering orifices. The Hylo Variator Valve Operator (illustrated) automatically throttles a rugged motor-operated valve in the steam main.

Webster engineers cooperated closely with the owners and the heating contractors, the Ryan Plumbing and Heating Company, in meeting publishing requirements. The press room is kept at 80 degrees constantly. Savings are achieved without adverse effect on production.

YMCA

Triangular insignia of the Young Men's Christian Association, representing "Spirit, Mind and Body."

THREE YMCA BUILDINGS REDUCE HEATING COSTS

Webster Heating Modernization Cuts Fuel Bills Without Impairing Heating Comfort

CINCINNATI "Y" SAVES $1,486

Cincinnati, O.—Three large Young Men's Christian Association buildings report sharp reductions in heating expense as the result of Webster Heating Modernization Programs completed within the last few years.

In downtown Cincinnati, the Association building saved 357 tons of coal within two years after the new heating system was installed. This is a cash saving of $1,486.

In neighboring Columbus, and in Minneapolis, Y. M. C. A. Buildings have achieved similar heating economies, without sacrificing heating comfort, by installing the Webster Moderator System of Steam Heating.

During the first two years in the Columbus "Y," the Webster Moderator System reduced coal consumption 395 tons. This is a cash saving of $1,294. Savings in this case, as at Cincinnati, are based on the difference between current coal bills and past average coal bills over a two or three-year period.

Cafeterias, auditoriums, class and club rooms, handball courts, garages, swimming pools, gymnasiums—every heating need of Association buildings is adequately met in these three installations. The distribution of steam is balanced so that all radiators heat evenly and rapidly.

The savings in heating expense are now available to these three Associations for carrying out a well-rounded program of Y. M. C. A. activities.

Marshall Murray, chief engineer and building superintendent of the Columbus Y. M. C. A., expresses complete satisfaction with the performance of the Webster Moderator System.

"The building has been comfortably heated at all times," Mr. Murray said. "There are no cold corner rooms. The warm-up period has been considerably shortened and even during the severest weather the system has met every demand made upon it."

Phoenix Building, Duluth, Minn.

HEATING COST REDUCED AFTER MODERNIZATION

Webster Moderator System Helps Phoenix Building, Duluth, To Check Heating Faults

SERVES SEVEN RETAIL STORES

Duluth, Minn.—Heating modernization helped the Phoenix Building, in downtown Duluth, to reduce its heating steam consumption from 359 to 206 lbs. of steam per degree day.

Installation of the Webster Moderator System together with new concealed Webster System Radiators was completed during the 1933-34 heating season as an important part of a thoroughgoing program of property modernization.

In a typical month before modernization, the Phoenix Building required 559,800 lbs. of steam. With the Webster Moderator System, after correction for degree day differences, the building saved 194,000 lbs. of steam—a cash reduction of $172 for a single month.

The heating modernization program is not solely responsible for these savings, but the owners credit the Webster Moderator System with a "very considerable portion of the reduction." Other factors include the lowering and insulation of ceilings on the second floor and a slight reduction in floor area.

Outdoor Thermostat which provides "Control-by-the-Weather."

In addition to the remarkable fuel savings, heating service is greatly improved. The new system is able to meet every heating need of a variety of tenants, by careful control of steam circulation.

Regardless of the severity of the weather, the entire building heats evenly and rapidly. The warm-up period has been considerably shortened.

"The Webster System has given us everything that we expected of it and more too," says H. L. George, representing the Massachusetts Real Estate Co., owners of the building. "There is absolutely no comparison in tenant satisfaction."

Savings in heating costs, comfortable indoor temperatures and minimum repair and maintenance bills are assured in new buildings as well as old by improved Webster Systems of Steam Heating.

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Tech Night—Saturday, June 6
Auspices of Senior Class

SCIENCE AND THE FINE ARTS

(*Continued from page 358*)

Starting with black and white it now embraces projection in color. Stereoscopic motion pictures are in the offing. It should be mentioned here that in its present form the motion picture in color was developed largely by Daniel Frost Comstock, VIII, '04, and Herbert Thomas Kalmus, VIII, '04. With reference to certain types of motion picture, the effect of their educational value in stimulating public interest in the fine arts cannot be overestimated.

The quality of musical sensations depends to a large degree upon the nature of the source and the acoustic properties of the space in which the sound is produced. A string of sheep gut stretched over a resonant box and stroked with the taut hair of a horse's tail is called a violin, but the quality of its tone depends markedly upon many details of scientific construction. In spite of all the homage paid to Stradivarius, progress is still being made in the production of a finer violin. Laboratory workers who have manipulated a Wheatstone's bridge may not know that his other great invention was the accordion. Those who rebel against the machine age should stop going to organ recitals: Behind the shutters of the tone orifice they will find perhaps the greatest assemblage of mechanical, electrical, and acoustical apparatus that man has ever brought together.

Out of a host of conflicting opinions regarding the treatment of interiors for the best sound effects, the decibel meter with scientific precision has indicated the proper arrangement. For the greatest enjoyment of music the reverberation constant, or the time of subsidence to inaudibility, should neither be zero nor too long. The music is more pleasing if the sound waves overlap somewhat at the listener's ear. In Symphony Hall at Boston the average reverberation constant is slightly less than two seconds, which is considered to be ideal for symphonic music. Broadcasting studios have been designed and surfaced with sound-absorbing materials and finally checked with regard to this principle by a decibel meter. For every person who listens to music today in a hall there are thousands who listen indirectly by radio. The fine art of classical music is thus brought into nearly every home in the land and the fidelity of its reproduction is one of the great triumphs of modern science. The motion picture accompanied by sound has been given added life and interest. This also will eventually be projected into the home by means of television. The phonograph by constant application of the fundamental sciences has been developed to such a state of perfection that it is often difficult to distinguish the direct sound of the musical instrument from its reproduction.

It has been proposed for many years to develop a new source of musical sound which will make it possible to duplicate the tonal quality of any existing instrument and add unlimited new sensations in tone which have never been heard before. These electrical instruments are just coming into production and it is safe to predict that the art of music, by this influence, will be broadened if not revolutionized. The art of musical composition must be given further (*Concluded on page 362*)

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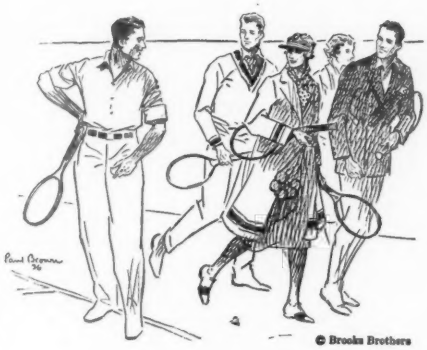

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The Institute publishes a variety of bulletins, as well as a catalogue of general information essential to the entering student. The Technology Review Bureau will be glad to send, gratis and post free upon request, one or more copies of any publication listed below, or to forward any special inquiry to the proper authority.

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SCIENCE AND THE FINE ARTS

(*Concluded from page 360*)

consideration, and a new type of artist must be developed to bring out the most pleasing tones of the instrument.

In the same manner that some of the charm of an oriental rug is said to be associated with its imperfections and divergence from machine-made patterns, the brilliance of a virtuoso is ascribed in part to his eccentricity and individuality of expression. Fear is often expressed that the new synthetic instruments will possess none of these properties. It must be remembered that a piano contains considerable machinery and consists of a harp sounded by hammers, levers, and keys. The new sound instruments will rather encourage greater individuality of expression, feeling, and technique, because they offer greater facility for the production of such characteristics.

What may be said as to the coöperation between science and poetry? Coleridge regarded science as the antithesis of poetry. Emily Dickinson evidently regarded science as a nuisance when she wrote:

> "Arcturus is his other name,
> I'd rather call him star!
> It's so unkind of science
> To go and interfere!"

But there seems to be some confusion among the poets. Anonymous, the greatest poet of them all, beseeches us with:

> "Twinkle, twinkle, little star!
> How I wonder what you are."

So it could be argued that science is not the antithesis but may be either a stimulus or an answer to poetry. When the poets begin to understand such things, may we not expect, in rhyme and rhythm, word pictures of the expanding universe, the flight of the photon, the intertwining of the chromosomes, and the roar of heavy waters. Quoting Emily Dickinson again:

> "The skies can't keep their secret!
> They tell it to the hills —
> The hills just tell the orchards —
> And they, the daffodils!"

Having found out very little about the skies from the daffodils the scientist may prefer to say:

> "The skies can't keep their secret!
> They tell it to hill and dale —
> Mount Wilson tells the spectroscope —
> And she tells George Ellery Hale." *

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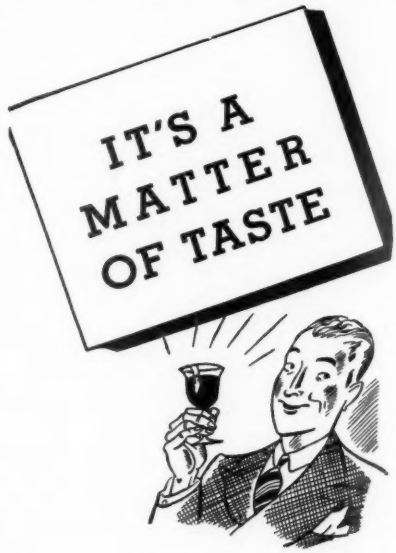

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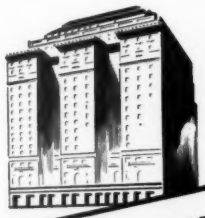

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THE STORY BEHIND YOUR LIGHT BILL

(*Continued from page 354*)

of the community adopting municipal utility operations. The effect of Federal grants for the construction of utility facilities merely emphasizes this situation, particularly if the condition of the nation as a whole is considered.

The elimination of private investment in utility properties can only result in a shifting of the burden of taxation now carried by the private utilities to those forms of private capital remaining untouched by the incursions of governmental ownership. The proper functions of government must continue, and in an increasingly complex social organization the *per capita* costs of maintaining these proper functions will undoubtedly increase. The elimination of large sources of tax revenue will thus entail a change in the incidence of taxation and an increase in its intensity upon the remaining sources of tax income. A complete analysis of the results that may reasonably be expected from the operation of all municipal systems by existing private systems must, therefore, give full consideration to the taxes that would have been paid under private operation.

The results of this analysis are presented on the accompanying tabulation. The application of the rate differentials would have resulted in slightly higher total domestic revenues, due to higher private-plant rate levels in two of the seven geographic areas considered. The small commercial group was consistently higher, although, as previously noted, only to the extent of the tax differential. If all operations for the effect of the tax differentials had been adjusted, there would have resulted a total savings, representing additional funds for expenditure in other economic fields, of $6,765,000 on revenues of $104,832,812 from the three groups combined. This total net difference is a measure of the actual disparity between private and municipal plant costs, as such costs directly affect the consumer/taxpayer.

TABLE I

ESTIMATED OVER-ALL SAVINGS TO THE PUBLIC THAT WOULD HAVE RESULTED FROM PRIVATE OPERATION OF MUNICIPAL ELECTRIC SYSTEMS

Data Developed from 1932 Census of Electrical Industries

	Residential Service	*Small Light and Pwr. Service*	*Large Light and Pwr. Service*	*Total of Three Groups*
Total M kilowatt sales....	1,379,390	1,265,596	448,863	3,094,949
Total revenue actually received.....	$64,769,464	$32,411,579	$7,651,769	$104,832,812
Additional total revenue that would have resulted under application of private plant rates.....	$ 640,000	$ 3,490,000	———	$ 4,130,000
Additional taxes that would have been paid by private plants — 10% of revenue	$ 6,540,000	$ 3,590,000	$ 765,000	$ 10,895,000
TOTAL OVER-ALL BENEFIT TO PUBLIC THAT WOULD HAVE ACCRUED UNDER PRIVATE OPERATION....	$ 5,900,000	$ 100,000	$ 765,000	$ 6,765,000

In the above analysis no consideration has been given to the inherent difference in the average levels of the "cost of money" to municipalities as compared with

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private enterprises. This dissimilarity is basic with the methods of financing that are available to the two types of operation. Thus, municipal enterprises are able to finance entirely through the medium of bonds at relatively low interest rates while the private systems must seek a portion of their capital through higher cost securities.

Whereas the private utility systems require an over-all average return in excess of six percent to meet interest and dividend charges, the municipal enterprises can finance at a net cost two to two-and-a-half points lower. This is possible because the purchaser of municipal bonds is making a loan supported by the full credit of the particular governmental body, which body can levy taxes to cover the payment of interest and principal. This right to levy taxes is enforceable in the courts and therefore, barring unduly depressed economic conditions or a gross overextension of governmental borrowing — with its concomitant increases in taxes to a confiscatory level — guarantees (so far as it is possible to guarantee any social contract) the fulfillment of the contractual agreement. The private utility has no such broad base upon which to finance and therefore can obtain, economically, not more than 50% to 60% of its capital requirements through a direct mortgage upon its entire property — the balance being obtained through the medium of equities.

As capital charges are a major portion of utility costs it would be reasonable to expect that municipal operations could have offered service at very materially lower total cost than the privately owned systems. With reported fixed capital in excess of 500 million dollars (in 1932) municipal electric systems, if operated at comparable efficiencies and at a probable capital cost differential of two to two-and-a-half per cent, should have been able to furnish service at a saving, from comparable private-plant costs, of more than ten millions of dollars annually. As disclosed above, this result was not achieved. The lack of success can only be attributed to an inherent inability on the part of the municipal systems as a group to operate with the same degree of efficiency as the private enterprises.

With continued agitation for a vast expansion of governmental investments in utility enterprises there arises the question of how long the market for municipal bonds will continue to absorb them at interest rates materially lower than can be obtained from investments in private enterprises. This (*Concluded on page 366*)

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THE STORY BEHIND YOUR LIGHT BILL

(*Concluded from page 365*)

natural trend to higher interest rates would affect not only the cost of such new enterprises but would also seriously impair the ability of municipalities economically to finance those functions that properly fall within the sphere of governmental activity. This result would have its inevitable effect upon general tax levels.

The Question of Governmental Operation

We thus return to the question of whether or not there is any necessity for, or advantage to be received from, vast governmental expenditures for the construction of competitive electric systems. A thorough consideration of the facts indicates the existence of very definite competitive influences affecting electric rate levels. These competitive controls tend to force prices for electric service progressively lower in the case of residential and small commercial service, and to keep prices at a level consistent with the general price structure in the case of industrial service. At the same time certain competitive cost barriers prevent the effective expansion of sales into markets already adequately supplied by other services. To develop these markets successfully would require rates below a sound economic level. To obtain such levels by means of governmental subsidies results merely in the transfer of costs from one group to another — a highly uneconomical process.

Although not previously discussed in this article it can be shown that the large average use values that accompany many abnormally low rates are the results of relatively few customers adopting electric service on a very expanded scale with the great bulk of customers refusing to adopt the marginal uses due to the existence of cheaper competitive services.

Electric service is essential to our existing social organization but the expansion of its use to fanciful levels is not necessary for the sound development of improved living standards. In fact, beyond certain limits, depending upon local conditions, the expansion of use is definitely restricted by competitive price barriers.

In view of these factors it is difficult to justify governmental subsidies for the purpose of offering competition, where effective competition is already present, or for the purpose of attempting to expand the use of a substitute service into competitive areas already adequately served. Furthermore, an analysis of the over-all effect of municipal operation in relation to private operation of utility services indicates greater efficiencies and lower over-all costs under the latter. Can any different results be expected under subsidized operations, if all true costs are included? Probably not.

From these facts one draws the conclusion that there exists no sound economic justification for expansion of governmental operations into the field of electric service. Whatever other reasons may exist, which justify this incursion into the sphere of private enterprise, are not known to the writer. It is difficult, however, to justify such expansion on any basis other than that of sound economics.

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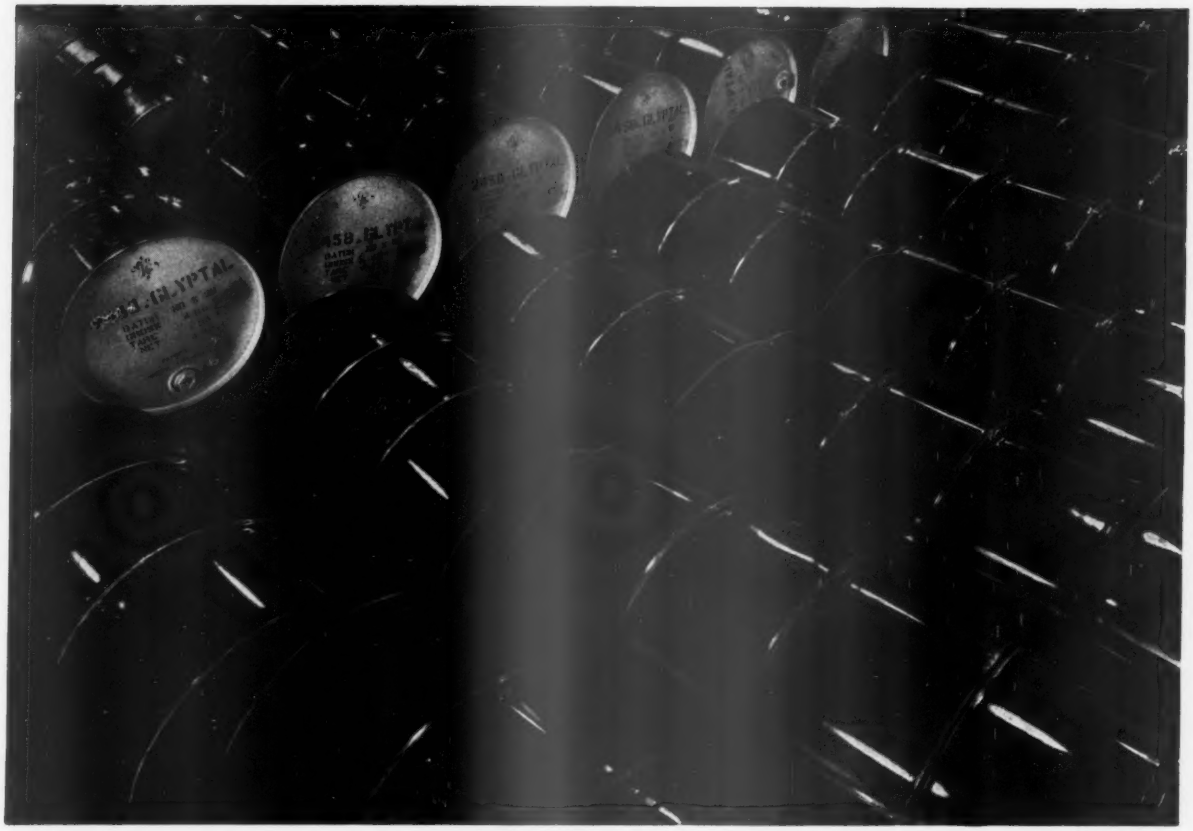

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Coil System: Seven low-resistance plug-in coils; Isolantite coil forms and improved design affording much better stability; coupling variable by rotating coil in plug rather than by shifting wavemeter.

Condenser: Modification of the new Type 722; improved mechanical construction with greater electrical stability; condenser plates straight-frequency-line shape; 7,500 divisions for 270 degree rotation of main dial; condenser may be set to 1 part in 25,000.

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